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(54) Title: INTRON FUSION CONSTRUCT AND METHOD OF USING FOR SELECTING HIGH-EXPRESSING PRODUCTION CELL LINES

(57) Abstract: This invention relates to a DNA construct, methods of selecting for high-expressing host cells, a method of producing a protein of interest in high yields and a method of producing eukaryotic cells having multiple copies of a sequence encoding a protein of interest. In one method, stable clones capable of producing a high level of a product of interest are generated from one step of a direct selection immediately after transfection.

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INTRON FUSION CONSTRUCT AND METHOD OF USING FOR SELECTING HIGH-
EXPRESSING PRODUCTION CELL LINES

This application claims priority under 35 U.S.C. § 119(e) from U.S. provisional application serial no. 60/426,095, filed November 14, 2002, which is herein incorporated by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a DNA construct, a method of selecting for high-expressing host cells, a method of producing a protein of interest in high yields and a method of producing eukaryotic cells having multiple copies of a sequence encoding a protein of interest.

Description of Background and Related Art

The discovery of methods for introducing DNA into living host cells in a functional form has provided the key to understanding many fundamental biological processes, and has made possible the production of important proteins and other molecules in commercially useful quantities.

Despite the general success of such gene transfer methods, several common problems exist that may limit the efficiency with which a gene encoding a desired protein can be introduced into and expressed in a host cell. One problem is knowing when the gene has been successfully transferred into recipient cells. A second problem is distinguishing between those cells that contain the gene and those that have survived the transfer procedures but do not contain the gene. A third problem is identifying and isolating those cells that contain the gene and that are expressing high levels of the protein encoded by the gene.

In general, the known methods for introducing genes into eukaryotic cells tend to be highly inefficient. Of the cells in a given culture, only a small proportion take up and express exogenously added DNA, and an even smaller proportion stably maintain that DNA.

Identification of those cells that have incorporated a product gene encoding a desired protein typically is achieved by introducing into the same cells another gene, commonly referred to

as a selectable gene, that encodes a selectable marker. A selectable marker is a protein that is necessary for the growth or survival of a host cell under the particular culture conditions chosen, such as an enzyme that confers resistance to an antibiotic or other drug, or an enzyme that compensates for a metabolic or catabolic defect in the host cell. For example, selectable genes commonly used with eukaryotic cells include the genes for aminoglycoside phosphotransferase (APH), hygromycin phosphotransferase (hyg), dihydrofolate reductase (DHFR), thymidine kinase (tk), neomycin resistance, puromycin resistance, glutamine synthetase, and asparagine synthetase.

The method of identifying a host cell that has incorporated one gene on the basis of expression by the host cell of a second incorporated gene encoding a selectable marker is referred to as cotransfection (or cotransfection). In that method, a gene encoding a desired polypeptide and a selection gene typically are introduced into the host cell simultaneously. In this case of simultaneous cotransfection, the gene encoding the desired polypeptide and the selectable gene may be present on a single DNA molecule or on separate DNA molecules prior to being introduced into the host cells. Wigler *et al.*, Cell, 16:777 (1979). Cells that have incorporated the gene encoding the desired polypeptide then are identified or isolated by culturing the cells under conditions that preferentially allow for the growth or survival of those cells that synthesize the selectable marker encoded by the selectable gene.

The level of expression of a gene introduced into a eukaryotic host cell depends on multiple factors, including gene copy number, efficiency of transcription, messenger RNA (mRNA) processing, stability, and translation efficiency. Accordingly, high level expression of a desired polypeptide typically will involve optimizing one or more of those factors.

For example, the level of protein production may be increased by covalently joining the coding sequence of the gene to a "strong" promoter or enhancer that will give high levels of transcription. Promoters and enhancers are nucleotide sequences that interact specifically with proteins in a host cell that are involved in transcription. Kriegler, Meth. Enzymol., 185:512 (1990); Maniatis *et al.*, Science, 236:1237 (1987). Promoters are located upstream of the coding sequence of a gene and facilitate transcription of the gene by RNA polymerase. Among the eukaryotic promoters that have been identified as strong promoters for high-level expression are the SV40 early promoter, adenovirus major late promoter, mouse metallothionein-I promoter, Rous sarcoma virus long terminal repeat, and human cytomegalovirus immediate early promoter (CMV).

Enhancers stimulate transcription from a linked promoter. Unlike promoters, enhancers are active when placed downstream from the transcription initiation site or at considerable distances from the promoter, although in practice enhancers may overlap physically and functionally with promoters. For example, all of the strong promoters listed above also contain strong enhancers. Bendig, Genetic Engineering, 7:91 (Academic Press, 1988).

The level of protein production also may be increased by increasing the gene copy number in the host cell. One method for obtaining high gene copy number is to directly introduce into the host cell multiple copies of the gene, for example, by using a large molar excess of the product gene relative to the selectable gene during cotransfection. Kaufman, Meth. Enzymol., 185:537 (1990). With this method, however, only a small proportion of the cotransfected cells will contain the product gene at high copy number. Furthermore, because no generally applicable, convenient method exists for distinguishing such cells from the majority of cells that contain fewer copies of the product gene, laborious and time-consuming screening methods typically are required to identify the desired high-copy number transfectants.

Another method for obtaining high gene copy number involves cloning the gene in a vector that is capable of replicating autonomously in the host cell. Examples of such vectors include mammalian expression vectors derived from Epstein-Barr virus or bovine papilloma virus, and yeast 2-micron plasmid vectors. Stephens & Hentschel, Biochem. J., 248:1 (1987); Yates *et al.*, Nature, 313:812 (1985); Beggs, Genetic Engineering, 2:175 (Academic Press, 1981).

Yet another method for obtaining high gene copy number involves gene amplification in the host cell. Gene amplification occurs naturally in eukaryotic cells at a relatively low frequency. Schimke, J. Biol. Chem., 263:5989 (1988). However, gene amplification also may be induced, or at least selected for, by exposing host cells to appropriate selective pressure. For example, in many cases it is possible to introduce a product gene together with an amplifiable gene into a host cell and subsequently select for amplification of the marker gene by exposing the cotransfected cells to sequentially increasing concentrations of a selective agent. Typically the product gene will be coamplified with the marker gene under such conditions.

The most widely used amplifiable gene for that purpose is a DHFR gene, which encodes a dihydrofolate reductase enzyme. The selection conditions used in conjunction with a DHFR gene are the absence of glycine, hypoxanthine and thymidine (GHT) with or without the presence of methotrexate (Mtx). A host cell is cotransfected with a product gene encoding a desired protein

and a DHFR gene, and transfectants are identified by first culturing the cells in GHT-free culture medium that may contain Mtx. A suitable host cell when a wild-type DHFR gene is used is the Chinese Hamster Ovary (CHO) cell line deficient in DHFR activity, prepared and propagated as described by Urlaub & Chasin, Proc. Nat. Acad. Sci. USA, 77:4216 (1980). The transfected cells then are exposed to successively higher amounts of Mtx. This leads to the synthesis of multiple copies of the DHFR gene, and concomitantly, multiple copies of the product gene. Schimke, J. Biol. Chem., 263:5989 (1988); Axel *et al.*, U.S. Patent No. 4,399,216; Axel *et al.*, U.S. Patent No. 4,634,665. Other references directed to co-transfection of a gene together with a genetic marker that allows for selection and subsequent amplification include Kaufman in Genetic Engineering, ed. J. Setlow (Plenum Press, New York), Vol. 9 (1987); Kaufman and Sharp, J. Mol. Biol., 159:601 (1982); Ringold *et al.*, J. Mol. Appl. Genet., 1:165-175 (1981); Kaufman *et al.*, Mol. Cell Biol., 5:1750-1759 (1985); Kaetzel and Nilson, J. Biol. Chem., 263:6244-6251 (1988); Hung *et al.*, Proc. Natl. Acad. Sci. USA, 83:261-264 (1986); Kaufman *et al.*, EMBO J., 6:87-93 (1987); Johnston and Kucey, Science, 242:1551-1554 (1988); Urlaub *et al.*, Cell, 33:405-412 (1983).

To extend the DHFR amplification method to other cell types, a mutant DHFR gene that encodes a protein with reduced sensitivity to methotrexate may be used in conjunction with host cells that contain normal numbers of an endogenous wild-type DHFR gene. Simonsen and Levinson, Proc. Natl. Acad. Sci. USA, 80:2495 (1983); Wigler *et al.*, Proc. Natl. Acad. Sci. USA, 77:3567-3570 (1980); Haber and Schimke, Somatic Cell Genetics, 8:499-508 (1982).

Alternatively, host cells may be co-transfected with the product gene, a DHFR gene, and a dominant selectable gene, such as a neo^r gene. Kim and Wold, Cell, 42:129 (1985); Capon *et al.*, U.S. Pat. No. 4,965,199. Transfectants are identified by first culturing the cells in culture medium containing neomycin (or the related drug G418), and the transfectants so identified then are selected for amplification of the DHFR gene and the product gene by exposure to successively increasing amounts of Mtx.

As will be appreciated from this discussion, the selection of recombinant host cells that express high levels of a desired protein generally is a multi-step process. In the first step, initial transfectants are selected that have incorporated the product gene and the selectable gene. In subsequent steps, the initial transfectants are subject to further selection for high-level expression of the selectable gene and then random screening for high-level expression of the product gene. To identify cells expressing high levels of the desired protein, typically one must screen large numbers

of transfectants. The majority of transfectants produce less than maximal levels of the desired protein. Further, Mtx resistance in DHFR transformants is at least partially conferred by varying degrees of gene amplification. Schimke, Cell, 37:705-713 (1984). The inadequacies of co-expression of the non-selected gene have been reported by Wold *et al.*, Proc. Natl. Acad. Sci. USA, 76:5684-5688 (1979). Instability of the amplified DNA is reported by Kaufman and Schimke, Mol. Cell Biol., 1:1069-1076 (1981); Haber and Schimke, Cell, 26:355-362 (1981); and Fedespiel *et al.*, J. Biol. Chem., 259:9127-9140 (1984).

Several methods have been described for directly selecting such recombinant host cells in a single step. One strategy involves co-transfecting host cells with a product gene and a DHFR gene, and selecting those cells that express high levels of DHFR by directly culturing in medium containing a high concentration of Mtx. Many of the cells selected in that manner also express the co-transfected product gene at high levels Page and Sydenham, Bio/Technology, 9:64 (1991). This method for single-step selection suffers from certain drawbacks that limit its usefulness. High-expressing cells obtained by direct culturing in medium containing a high level of a selection agent may have poor growth and stability characteristics, thus limiting their usefulness for long-term production processes Page and Snyderman, Bio/Technology, 9:64 (1991). Single-step selection for high-level resistance to Mtx may produce cells with an altered, Mtx-resistant DHFR enzyme, or cells that have altered Mtx transport properties, rather than cells containing amplified genes. Haber *et al.*, J. Biol. Chem., 256:9501 (1981); Assaraf and Schimke, Proc. Natl. Acad. Sci. USA, 84:7154 (1987).

Another method involves the use of polycistronic mRNA expression vectors containing a product gene at the 5' end of the transcribed region and a selectable gene at the 3' end. Because translation of the selectable gene at the 3' end of the polycistronic mRNA is inefficient, such vectors exhibit preferential translation of the product gene and require high levels of polycistronic mRNA to survive selection. Kaufman, Meth. Enzymol., 185:487 (1990); Kaufman, Meth. Enzymol., 185:537 (1990); Kaufman *et al.*, EMBO J., 6:187 (1987). Accordingly, cells expressing high levels of the desired protein product may be obtained in a single step by culturing the initial transfectants in medium containing a selection agent appropriate for use with the particular selectable gene. However, the utility of these vectors is variable because of the unpredictable influence of the upstream product reading frame on selectable marker translation and because the upstream reading frame sometimes becomes deleted during methotrexate amplification (Kaufman

et al., J. Mol. Biol., **159**:601-621 (1982); Levinson, Methods in Enzymology, San Diego: Academic Press, Inc. (1990)). Later vectors incorporated an internal translation initiation site derived from members of the picornavirus family which is positioned between the product gene and the selectable gene (Pelletier *et al.*, Nature, **334**:320 (1988); Jang *et al.*, J. Virol., **63**:1651 (1989)).

A third method for single-step selection involves use of a DNA construct with a selectable gene containing an intron within which is located a gene encoding the protein of interest. See U.S. Patent No. 5,043,270 and Abrams *et al.*, J. Biol. Chem., **264**(24): 14016-14021 (1989). In yet another single-step selection method, host cells are co-transfected with an intron-modified selectable gene and a gene encoding the protein of interest. See WO 92/17566, published October 15, 1992. The intron-modified gene is prepared by inserting into the transcribed region of a selectable gene an intron of such length that the intron is correctly spliced from the corresponding mRNA precursor at low efficiency, so that the amount of selectable marker produced from the intron-modified selectable gene is substantially less than that produced from the starting selectable gene. These vectors help to insure the integrity of the integrated DNA construct, but transcriptional linkage is not achieved as selectable gene and the protein gene are driven by separate promoters.

Other mammalian expression vectors that have single transcription units have been described. Retroviral vectors have been constructed (Cepko *et al.*, Cell, **37**:1053-1062 (1984)) in which a cDNA is inserted between the endogenous Moloney murine leukemia virus (M-MuLV) splice donor and splice acceptor sites which are followed by a neomycin resistance gene. This vector has been used to express a variety of gene products following retroviral infection of several cell types.

A method for selecting recombinant host cells expressing high levels of a desired protein was previously described by the applicants in Lucas *et al.*, Nucleic Acid Research, **24**, No. 9: 1774-1779 and U.S. Patent No. 5,561,053. That method utilizes eukaryotic host cells harboring a DNA construct comprising a selectable gene (preferably an amplifiable gene) and a product gene provided 3' to the selectable gene. The selectable gene is positioned within an intron defined by a splice donor site and a splice acceptor site and the selectable gene and product gene are under the transcriptional control of a single transcriptional regulatory region. The splice donor site is generally an efficient splice donor site and thereby regulates expression of the product gene using the transcriptional regulatory region. The transfected cells are cultured so as to express the gene encoding the product in a selective medium which may contain an amplifying agent for sufficient

time to allow cells having multiple copies of the product gene, or cells with a single (or multiple) copy of the gene in a chromosomal loci with high transcriptional activity to be identified.

Other fusion expression constructs have been developed. For example, a fusion of green fluorescent protein with the Zeocin-resistance marker construct has been created. Bennet, R.P. *et al.*, Biotechniques, 24(3):478-82, 1998 March. Such constructs were used to allow visual screening and drug selection of transfected eukaryotic cells.

In another example, human prothrombin was overexpressed in transformed eukaryotic cells using a dominant bifunctional selection and amplification marker. Herlitschka, Sabine E. *et al.*, Protein Expression and Purification, 8, 358-364, 1996 July. In this reference the marker consisted of the murine wild-type dihydrofolate reductase cDNA and the *E. coli* hygromycin phosphotransferase gene fused in frame. The gene of interest is connected, upstream, by the EMCV untranslated region to the fusion marker gene, forming a dicistronic transcription unit.

With the state of the art in mind, it is one object of the present invention to increase the level of homogeneity with regard to expression levels of stable clones transfected with a product gene of interest, by expressing fused selectable markers (i.e. DHFR and puromycin) and a protein of interest from a single promoter.

It is another object to provide a method for selecting stable, recombinant host cells that express high levels of a desired protein product, which method is rapid and convenient to perform, and reduces the numbers of transfected cells which need to be screened. Furthermore, it is an object to allow high levels of single and multiple unit polypeptides to be rapidly generated from clones or pools of stable host cell transfectants.

It is an additional object to provide expression vectors which bias for active integration events (*i.e.* have an increased tendency to generate transformants wherein the DNA construct is inserted into a region of the genome of the host cell which results in high level expression of the product gene) and can accommodate a variety of product genes without the need for modification.

SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to a DNA construct (DNA molecule) comprising a 5' transcriptional initiation site and a 3' transcriptional termination site, two selectable genes that have been fused into one open reading frame (preferably amplifiable genes) and a product gene provided 3' to the fused selectable genes, a transcriptional regulatory region

regulating transcription of both the fused selectable genes and the product gene, the fused selectable genes positioned within an intron defined by a splice donor site and a splice acceptor site. The splice donor site preferably comprises an effective splice donor sequence as herein defined and thereby regulates expression of the product gene using the transcriptional regulatory region.

In another embodiment, the invention provides a method for producing a product of interest comprising culturing a eukaryotic cell which has been transfected with the DNA construct described above, so as to express the product gene and recovering the product.

In a further embodiment, the invention provides a method for producing eukaryotic cells having multiple copies of the product gene comprising transfecting eukaryotic cells with the DNA construct described above (where the selectable fused genes are amplifiable genes), growing the cells in a selective medium comprising an amplifying agent(s) for a sufficient time for amplification to occur, and selecting cells having multiple copies of the product gene. After transfection of the host cells, most of the transfectants fail to exhibit the selectable phenotype characteristic of the protein encoded by either of the selectable genes, but surprisingly a small proportion of the transfectants do exhibit one or both of the selectable phenotype, and among those transfectants, the majority are found to express high levels of the desired product encoded by the product gene. Thus, the invention provides an improved method for the selection of recombinant host cells expressing high levels of a desired product, which method is useful with a wide variety of eukaryotic host cells and avoids the problems inherent in, and improves upon, existing cell selection technology.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates schematically the construction of the pSV.IPD. The gene for the protein of interest would be inserted at the polylinker site.

Figures 2-1 to 2-4 depict the nucleotide sequence of the pSV.IPUR plasmid used in constructing pSV.IPD (SEQ ID NO 1).

Figures 3-1 to 3-4 depict the nucleotide sequence of the pSV.ID plasmid used in constructing pSV.IPD (SEQ ID NO 2).

Figures 4-1 to 4-4 depict the nucleotide sequence of the pSV.IPD (SEQ ID NO 3).

Figure 5 illustrates schematically the plasmid, pSV.ID.VEGF, used as a control in Example 1.

Figure 6 illustrates schematically the plasmid, pSV.IPD.2C4, used in Example 1 (SEQ ID NO 4).

Figures 7-1 to 7-8 depict the nucleotide sequence of the pSV.IPD.2C4 plasmid used in Example 1.

Figure 8 depicts a FACS analysis of transiently transfected CHO cells with a GTP plasmid in 250ml spinner transfection. FACS analysis was performed 24 hours after transfection.

Figure 9 depicts the expression level of clones from traditional 10nM MTX selection. Cells were transfected with commercial transfection reagent and directly selected in 10 nM MTX. Individual clones were grown in a 96-well plate. Product accumulated for 6 days prior to ELISA.

Figures 10-1 and 10-2 depict the expression level of clones from 25 and 50 nM MTX direct selections, respectively, of SV40-based constructs derived from spinner transfection. The assay was performed the same as in Figure 9.

Figure 11 depicts the expression level of clones from 25 nM MTX direct selection of CMV-based construct derived from spinner transfection. The assay was performed the same as in Figure 9.

Figure 12 depicts the titer evaluation in Miniform. Samples were collected every day and submitted to an HPLC protein A assay for titer.

Figure 13-1 to 13-7 depict the nucleotide sequence of the pCMV.IPD.Heterologous polypeptide (HP) plasmid used in Example 3.

Figure 14-1 to 14-8 depicts the nucleotide sequence of the pSV40.IPD.HP plasmid used in Example 3.

Figure 15 illustrates schematically the plasmid, pCMV.IPD.HP, used in Example 3.

Figure 16 illustrates a time line and titer comparison between a traditional selection and direct selection method described in Example 3. Equivalent titers are indicated horizontally across the illustration. For example, the titers for a 200/300nM SV40-plasmid traditional selection, 100nM SV40-plasmid direct selection and 25nm CMV-plasmid direct selection are roughly equivalent.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Definitions:

The "DNA construct" disclosed herein comprises a non-naturally occurring DNA molecule or chemical analog which can either be provided as an isolate or integrated in another DNA molecule *e.g.* in an expression vector or the chromosome of an eukaryotic host cell.

The term "selectable gene" as used herein refers to a DNA that encodes a selectable marker necessary for the growth or survival of a host cell under the particular cell culture conditions chosen. Accordingly, a host cell that is transformed with a selectable gene will be capable of growth or survival under certain cell culture conditions wherein a non-transfected host cell is not capable of growth or survival. Typically, a selectable gene will confer resistance to a drug or compensate for a metabolic or catabolic defect in the host cell. Examples of selectable genes are provided in the following table. See also Kaufman, Methods in Enzymology, **185**: 537-566 (1990), for a review of these.

"Fused selectable genes" as used herein refers to a DNA that encodes at least two selectable markers in the same open reading frame and inserted into an intron sequence.

TABLE 1**Examples of Selectable Genes and their Selection Agents**

Selection Agent	Selectable Gene
Puromycin	Puromycin-N-acetyltransferase
Methotrexate	Dihydrofolate reductase
Cadmium	Metallothionein
PALA	CAD
Xyl-A-or adenosine and 2'-deoxycoformycin	Adenosine deaminase
Adenine, azaserine, and coformycin	Adenylate deaminase
6-Azauridine, pyrazofuran	UMP Synthetase
Mycophenolic acid	IMP 5'-dehydrogenase
Mycophenolic acid with limiting xanthine	Xanthine-guanine phosphoribosyltransferase
Hypoxanthine, aminopterin, and thymidine (HAT)	Mutant HGPRTase or mutant thymidine kinase
5-Fluorodeoxyuridine	Thymidylate synthetase
Multiple drugs <i>e.g.</i> adriamycin, vincristine or colchicine	P-glycoprotein 170
Aphidicolin	Ribonucleotide reductase
Methionine sulfoximine	Glutamine synthetase

β -Aspartyl hydroxamate or Albizziin	Asparagine synthetase
Canavanine	Arginosuccinate synthetase
α -Difluoromethylornithine	Ornithine decarboxylase
Compactin	HMG-CoA reductase
Tunicamycin	N-Acetylglucosaminyl transferase
Borrelidin	Threonyl-tRNA synthetase
Ouabain	Na ⁺ K ⁺ -ATPase

The preferred selectable genes are amplifiable genes. As used herein, the term "amplifiable gene" refers to a gene which is amplified (*i.e.* additional copies of the gene are generated which survive in intrachromosomal or extrachromosomal form) under certain conditions. The amplifiable gene(s) usually encodes an enzyme (*i.e.* an amplifiable marker) which is required for growth of eukaryotic cells under those conditions. For example, the gene may encode DHFR which is amplified when a host cell transformed therewith is grown in Mtx. According to Kaufman, the selectable genes in Table 1 above can also be considered amplifiable genes. An example of a selectable gene which is generally not considered to be an amplifiable gene is the neomycin resistance gene (Cepko *et al.*, *supra*).

As used herein, "selective medium" refers to nutrient solution used for growing eukaryotic cells which have the selectable gene(s) and therefore is deficient in components supplied by the selectable gene or includes a "selection agent". Commercially available media based on formulations such as Ham's F10 (Sigma), Minimal Essential Medium ((MEM), Sigma), RPMI-1640 (Sigma), and Dulbecco's Modified Eagle's Medium ((DMEM), Sigma) are exemplary nutrient solutions. In addition, any of the media described in Ham and Wallace, Meth. Enz., **58:44** (1979), Barnes and Sato, Anal. Biochem., **102:255** (1980), U.S. Patent Nos. 4,767,704; 4,657,866; 4,927,762; or 4,560,655; WO 90/03430; WO 87/00195; U.S. Patent Re. 30,985; or U.S. Patent No. 5,122,469, the disclosures of all of which are incorporated herein by reference, may be used as culture media. Any of these media may be supplemented as necessary with hormones and/or other

growth factors (such as insulin, transferrin, or epidermal growth factor), salts (such as sodium chloride, calcium, magnesium, and phosphate), buffers (such as HEPES), nucleosides (such as adenosine and thymidine), antibiotics (such as GentamycinTM drug), trace elements (defined as inorganic compounds usually present at final concentrations in the micromolar range), and glucose or an equivalent energy source. Any other necessary supplements may also be included at appropriate concentrations that would be known to those skilled in the art. The preferred nutrient solution comprises fetal bovine serum.

The term "selection agent" refers to a substance that interferes with the growth or survival of a host cell possibly because the cell is deficient in a particular selectable gene. Examples of selection agents are presented in Table 1 above. The selection agent preferably comprises an "amplifying agent" which is defined for purposes herein as an agent for amplifying copies of the amplifiable gene or causing integration of multiple copies of the amplifiable gene into the genome, such as Mtx if the amplifiable gene is DHFR. See Table 1 for examples of amplifying agents.

As used herein, the terms "direct selection" or "direct culturing" means the first exposure to selective conditions either without MTX or GHT or with MTX, and production of a heterologous polypeptide in an amount of about 250mg/l, 400mg/l, 600mg/l or 800mg/l up to about 1g/l or more.

As used herein, the term "transcriptional initiation site" refers to the nucleic acid in the DNA construct corresponding to the first nucleic acid incorporated into the primary transcript, *i.e.*, the mRNA precursor, which site is generally provided at, or adjacent to, the 5' end of the DNA construct.

The term "transcriptional termination site" refers to a sequence of DNA, normally represented at the 3' end of the DNA construct, that causes RNA polymerase to terminate transcription.

As used herein, "transcriptional regulatory region" refers to a region of the DNA construct that regulates transcription of the selectable gene and the product gene. The transcriptional regulatory region normally refers to a promoter sequence (*i.e.* a region of DNA involved in binding of RNA polymerase to initiate transcription) which can be constitutive or inducible and, optionally, an enhancer (*i.e.* a *cis*-acting DNA element, usually from about 10-300 bp, that acts on a promoter to increase its transcription).

As used herein, "product gene" refers to DNA that encodes a desired protein or polypeptide product. Any product gene that is capable of expression in a host cell may be used, although the methods of the invention are particularly suited for obtaining high-level expression of a product gene that is not also a selectable or amplifiable gene. Accordingly, the protein or polypeptide encoded by a product gene typically will be one that is not necessary for the growth or survival of a host cell under the particular cell culture conditions chosen. For example, product genes suitably encode a peptide, or may encode a polypeptide sequence of amino acids for which the chain length is sufficient to produce higher levels of tertiary and/or quaternary structure.

Examples of bacterial polypeptides or proteins include, *e.g.*, alkaline phosphatase and β -lactamase. Examples of mammalian polypeptides or proteins include molecules such as renin; a growth hormone, including human growth hormone, and bovine growth hormone; growth hormone releasing factor; parathyroid hormone; thyroid stimulating hormone; lipoproteins; alpha-1-antitrypsin; insulin A-chain; insulin B-chain; proinsulin; follicle stimulating hormone; calcitonin; luteinizing hormone; glucagon; clotting factors such as factor VIIIc, factor IX, tissue factor, and von Willebrands factor; anti-clotting factors such as Protein C; atrial natriuretic factor; lung surfactant; a plasminogen activator, such as urokinase or human urine or tissue-type plasminogen activator (t-PA); bombesin; thrombin; hemopoietic growth factor; tumor necrosis factor-alpha and -beta; enkephalinase; RANTES (regulated on activation normally T-cell expressed and secreted); human macrophage inflammatory protein (MIP-1-alpha); a serum albumin such as human serum albumin; mullerian-inhibiting substance; relaxin A-chain; relaxin B-chain; prorelaxin; mouse gonadotropin-associated peptide; a microbial protein, such as beta-lactamase; DNase; inhibin; activin; vascular endothelial growth factor (VEGF); receptors for hormones or growth factors; integrin; protein A or D; rheumatoid factors; a neurotrophic factor such as bone-derived neurotrophic factor (BDNF), neurotrophin-3, -4, -5, or -6 (NT-3, NT-4, NT-5, or NT-6), or a nerve growth factor such as NGF- β ; platelet-derived growth factor (PDGF); fibroblast growth factor such as aFGF and bFGF; epidermal growth factor (EGF); transforming growth factor (TGF) such as TGF-alpha and TGF-beta; including TGF- β 1, TGF- β 2, TGF- β 3, TGF- β 4, or TGF- β 5; insulin-like growth factor-I and -II (IGF-I and IGF-II); des(1-3)-IGF-I (brain IGF-I), insulin-like growth factor binding proteins; CD proteins such as CD-3, CD-4, CD-8, and CD-19; erythropoietin; osteoinductive factors; immunotoxins; a bone morphogenetic protein (BMP); an interferon such as interferon-alpha, -beta, and -gamma; colony stimulating factors (CSFs), *e.g.*, M-CSF, GM-CSF,

and G-CSF; interleukins (ILs), *e.g.*, IL-1 to IL-10; superoxide dismutase; T-cell receptors; surface membrane proteins; decay accelerating factor; viral antigen such as, for example, a portion of the AIDS envelope; transport proteins; homing receptors; addressins; regulatory proteins; antibodies; chimeric proteins such as immunoadhesins and fragments of any of the above-listed polypeptides.

The product gene preferably does not consist of an anti-sense sequence for inhibiting the expression of a gene present in the host. Preferred proteins herein are therapeutic proteins such as TGF- β , TGF- α , PDGF, EGF, FGF, IGF-I, DNase, plasminogen activators such as t-PA, clotting factors such as tissue factor and factor VIII, hormones such as relaxin and insulin, cytokines such as IFN- γ , chimeric proteins such as TNF receptor IgG immunoadhesin (TNFr-IgG) or antibodies such as anti-IgE. An example of an antibody that can be produced with the pSV.IDP plasmid (Figure 4) is anti-HER2 Neu antibody, 2C4, as provided in Example 1, *supra*.

The term "intron" as used herein refers to a nucleotide sequence present within the transcribed region of a gene or within a messenger RNA precursor, which nucleotide sequence is capable of being excised, or spliced, from the messenger RNA precursor by a host cell prior to translation. Introns suitable for use in the present invention are suitably prepared by any of several methods that are well known in the art, such as purification from a naturally occurring nucleic acid or *de novo* synthesis. The introns present in many naturally occurring eukaryotic genes have been identified and characterized. Mount, Nuc. Acids Res., **10**:459 (1982). Artificial introns comprising functional splice sites also have been described. Winey *et al.*, Mol. Cell Biol., **9**:329 (1989); Gattermann *et al.*, Mol. Cell Biol., **9**:1526 (1989). Introns may be obtained from naturally occurring nucleic acids, for example, by digestion of a naturally occurring nucleic acid with a suitable restriction endonuclease, or by PCR cloning using primers complementary to sequences at the 5' and 3' ends of the intron. Alternatively, introns of defined sequence and length may be prepared synthetically using various methods in organic chemistry. Narang *et al.*, Meth. Enzymol., **68**:90 (1979); Caruthers *et al.*, Meth. Enzymol., **154**:287 (1985); Froehler *et al.*, Nuc. Acids Res., **14**:5399 (1986).

As used herein "splice donor site" or "SD" refers to the DNA sequence immediately surrounding the exon-intron boundary at the 5' end of the intron, where the "exon" comprises the nucleic acid 5' to the intron. Many splice donor sites have been characterized and Ohshima *et al.*, J. Mol. Biol., **195**:247-259 (1987) provides a review of these. An "efficient splice donor sequence" refers to a nucleic acid sequence encoding a splice donor site wherein the efficiency of splicing of

messenger RNA precursors having the splice donor sequence is between about 80 to 99% and preferably 90 to 95% as determined by quantitative PCR. Examples of efficient splice donor sequences include the wild type (WT) *ras* splice donor sequence and the GAC:GTAAGT sequence of Example 3. Other efficient splice donor sequences can be readily selected using the techniques for measuring the efficiency of splicing disclosed herein.

The terms "PCR" and "polymerase chain reaction" as used herein refer to the *in vitro* amplification method described in US Patent No. 4,683,195 (issued July 28, 1987). In general, the PCR method involves repeated cycles of primer extension synthesis, using two DNA primers capable of hybridizing preferentially to a template nucleic acid comprising the nucleotide sequence to be amplified. The PCR method can be used to clone specific DNA sequences from total genomic DNA, cDNA transcribed from cellular RNA, viral or plasmid DNAs. Wang & Mark, in PCR Protocols, pp.70-75 (Academic Press, 1990); Scharf, in PCR Protocols, pp. 84-98; Kawasaki & Wang, in PCR Technology, pp. 89-97 (Stockton Press, 1989). Reverse transcription-polymerase chain reaction (RT-PCR) can be used to analyze RNA samples containing mixtures of spliced and unspliced mRNA transcripts. Fluorescently tagged primers designed to span the intron are used to amplify both spliced and unspliced targets. The resultant amplification products are then separated by gel electrophoresis and quantitated by measuring the fluorescent emission of the appropriate band(s). A comparison is made to determine the amount of spliced and unspliced transcripts present in the RNA sample.

One preferred splice donor sequence is a "consensus splice donor sequence". The nucleotide sequences surrounding intron splice sites, which sequences are evolutionarily highly conserved, are referred to as "consensus splice donor sequences". In the mRNAs of higher eukaryotes, the 5' splice site occurs within the consensus sequence AG:GUAAGU (wherein the colon denotes the site of cleavage and ligation). In the mRNAs of yeast, the 5' splice site is bounded by the consensus sequence :GUAUGU. Padgett, *et al.*, Ann. Rev. Biochem., 55:1119 (1986).

The expression "splice acceptor site" or "SA" refers to the sequence immediately surrounding the intron-exon boundary at the 3' end of the intron, where the "exon" comprises the nucleic acid 3' to the intron. Many splice acceptor sites have been characterized and Ohshima *et al.*, J. Mol. Biol., 195:247-259 (1987) provides a review of these. The preferred splice acceptor site is an efficient splice acceptor site which refers to a nucleic acid sequence encoding a splice

acceptor site wherein the efficiency of splicing of messenger RNA precursors having the splice acceptor site is between about 80 to 99% and preferably 90 to 95% as determined by quantitative PCR. The splice acceptor site may comprise a consensus sequence. In the mRNAs of higher eukaryotes, the 3' splice acceptor site occurs within the consensus sequence (U/C)₁₁NCAG:G. In the mRNAs of yeast, the 3' acceptor splice site is bounded by the consensus sequence (C/U)AG:. Padgett, *et al.*, *supra*.

As used herein "culturing for sufficient time to allow amplification to occur" refers to the act of physically culturing the eukaryotic host cells which have been transformed with the DNA construct in cell culture media containing the amplifying agent, until the copy number of the amplifiable gene (and preferably also the copy number of the product gene) in the host cells has increased relative to the transformed cells prior to this culturing.

The term "expression" as used herein refers to transcription or translation occurring within a host cell. The level of expression of a product gene in a host cell may be determined on the basis of either the amount of corresponding mRNA that is present in the cell or the amount of the protein encoded by the product gene that is produced by the cell. For example, mRNA transcribed from a product gene is desirably quantitated by northern hybridization or quantitative real-time PCR. Sambrook, *et al.*, Molecular Cloning: A Laboratory Manual, pp. 7.3-7.57 (Cold Spring Harbor Laboratory Press, 1989). Protein encoded by a product gene can be quantitated either by assaying for the biological activity of the protein or by employing assays that are independent of such activity, such as western blotting or radioimmunoassay using antibodies that are capable of reacting with the protein. Sambrook, *et al.*, Molecular Cloning: A Laboratory Manual, pp. 18.1-18.88 (Cold Spring Harbor Laboratory Press, 1989).

Modes for Carrying Out the Invention

Methods and compositions are provided for enhancing the stability and/or copy number of a transcribed sequence in order to allow for elevated levels of a RNA sequence of interest. In general, the methods of the present invention involve transfecting a eukaryotic host cell with an expression vector comprising both a product gene encoding a desired polypeptide and fused selectable genes.

Selectable genes and product genes may be obtained from genomic DNA, cDNA transcribed from cellular RNA, or by *in vitro* synthesis. For example, libraries are screened with

probes (such as antibodies or oligonucleotides of about 20-80 bases) designed to identify the selectable gene or the product gene (or the protein(s) encoded thereby). Screening the cDNA or genomic library with the selected probe may be conducted using standard procedures as described in chapters 10-12 of Sambrook *et al.*, Molecular Cloning: A Laboratory Manual (New York: Cold Spring Harbor Laboratory Press, 1989). An alternative means to isolate the selectable gene or product gene is to use PCR methodology as described in section 14 of Sambrook *et al.*, *supra*.

A preferred method of practicing this invention is to use carefully selected oligonucleotide sequences to screen cDNA libraries from various tissues known to contain the selectable gene or product gene. The oligonucleotide sequences selected as probes should be of sufficient length and sufficiently unambiguous that false positives are minimized.

The oligonucleotide generally is labeled such that it can be detected upon hybridization to DNA in the library being screened. The preferred method of labeling is to use ^{32}P -labeled ATP with polynucleotide kinase, as is well known in the art, to radiolabel the oligonucleotide. However, other methods may be used to label the oligonucleotide, including, but not limited to, biotinylation or enzyme labeling.

Sometimes, the DNA encoding the fused selectable genes and product gene is preceded by DNA encoding a signal sequence having a specific cleavage site at the N-terminus of the mature protein or polypeptide. In general, the signal sequence may be a component of the expression vector, or it may be a part of the selectable gene or product gene that is inserted into the expression vector. If a heterologous signal sequence is used, it preferably is one that is recognized and processed (*i.e.*, cleaved by a signal peptidase) by the host cell. For yeast secretion the native signal sequence may be substituted by, *e.g.*, the yeast invertase leader, alpha factor leader (including *Saccharomyces* and *Kluyveromyces* α -factor leaders, the latter described in U.S. Pat. No. 5,010,182 issued 23 April 1991), or acid phosphatase leader, the *C. albicans* glucoamylase leader (EP 362,179 published 4 April 1990), or the signal described in WO 90/13646 published 15 November 1990. In mammalian cell expression the native signal sequence of the protein of interest is satisfactory, although other mammalian signal sequences may be suitable, such as signal sequences from secreted polypeptides of the same or related species, as well as viral secretory leaders, for example, the herpes simplex gD signal. The DNA for such precursor region is ligated in reading frame to the fused selectable genes or product gene.

As shown in Figure 1, the fused selectable genes are generally provided at the 5' end of the DNA construct and are followed by the product gene (which would be inserted into the linker site). Therefore, the full-length (non-spliced) message will contain, for example, the PURO-DHFR fusion as the first open reading frame and will therefore generate PURO-DHFR protein to allow selection of stable transfectants. The full length message is not expected to generate appreciable amounts of the protein of interest as the second AUG in a dicistronic message is an inefficient initiator of translation in mammalian cells (Kozak, J. Cell Biol., **115**: 887-903 (1991)).

The fused selectable genes are positioned within an intron. Introns are noncoding nucleotide sequences, normally present within many eukaryotic genes, which are removed from newly transcribed mRNA precursors in a multiple-step process collectively referred to as splicing.

A single mechanism is thought to be responsible for the splicing of mRNA precursors in mammalian, plant, and yeast cells. In general, the process of splicing requires that the 5' and 3' ends of the intron be correctly cleaved and the resulting ends of the mRNA be accurately joined, such that a mature mRNA having the proper reading frame for protein synthesis is produced. Analysis of a variety of naturally occurring and synthetically constructed mutant genes has shown that nucleotide changes at many of the positions within the consensus sequences at the 5' and 3' splice sites have the effect of reducing or abolishing the synthesis of mature mRNA. Sharp, Science, **235**:766 (1987); Padgett, *et al.*, Ann. Rev. Biochem., **55**:1119 (1986); Green, Ann. Rev. Genet., **20**:671 (1986). Mutational studies also have shown that RNA secondary structures involving splicing sites can affect the efficiency of splicing. Solnick, Cell, **43**:667 (1985); Konarska, *et al.*, Cell, **42**:165 (1985).

The length of the intron may also affect the efficiency of splicing. By making deletion mutations of different sizes within the large intron of the rabbit beta-globin gene, Wieringa, *et al.* determined that the minimum intron length necessary for correct splicing is about 69 nucleotides. Cell, **37**:915 (1984). Similar studies of the intron of the adenovirus E1A region have shown that an intron length of about 78 nucleotides allows correct splicing to occur, but at reduced efficiency. Increasing the length of the intron to 91 nucleotides restores normal splicing efficiency, whereas truncating the intron to 63 nucleotides abolishes correct splicing. Ulfendahl, *et al.*, Nuc. Acids Res., **13**:6299 (1985).

To be useful in the invention, the intron must have a length such that splicing of the intron from the mRNA is efficient. The preparation of introns of differing lengths is a routine matter,

involving methods well known in the art, such as *de novo* synthesis or *in vitro* deletion mutagenesis of an existing intron. Typically, the intron will have a length of at least about 150 nucleotides, since introns which are shorter than this tend to be spliced less efficiently. The upper limit for the length of the intron can be up to 30 kB or more. However, as a general proposition, the intron is generally less than about 10 kB in length.

The intron is modified to contain the fused selectable genes not normally present within the intron using any of the various known methods for modifying a nucleic acid *in vitro*. Typically, the fused selectable genes will be introduced into an intron by first cleaving the intron with a restriction endonuclease, and then covalently joining the resulting restriction fragments to the fused selectable genes in the correct orientation for host cell expression, for example by ligation with a DNA ligase enzyme.

The DNA construct is dicistronic, *i.e.* the fused selectable genes and product gene are both under the transcriptional control of a single transcriptional regulatory region. As mentioned above, the transcriptional regulatory region comprises a promoter. Suitable promoting sequences for use with yeast hosts include the promoters for 3-phosphoglycerate kinase (Hitzeman *et al.*, J. Biol. Chem., **255**:2073 (1980)) or other glycolytic enzymes (Hess *et al.*, J. Adv. Enzyme Reg., **7**:149 (1968); and Holland, Biochemistry, **17**:4900 (1978)), such as enolase, glyceraldehyde-3-phosphate dehydrogenase, hexokinase, pyruvate decarboxylase, phosphofructokinase, glucose-6-phosphate isomerase, 3-phosphoglycerate mutase, pyruvate kinase, triosephosphate isomerase, phosphoglucose isomerase, and glucokinase.

Other yeast promoters, which are inducible promoters having the additional advantage of transcription controlled by growth conditions, are the promoter regions for alcohol dehydrogenase 2, isocytochrome C, acid phosphatase, degradative enzymes associated with nitrogen metabolism, metallothionein, glyceraldehyde-3-phosphate dehydrogenase, and enzymes responsible for maltose and galactose utilization. Suitable vectors and promoters for use in yeast expression are further described in Hitzeman *et al.*, EP 73,657A. Yeast enhancers also are advantageously used with yeast promoters.

Expression control sequences are known for eukaryotes. Virtually all eukaryotic genes have an AT-rich region located approximately 25 to 30 bases upstream from the site where transcription is initiated. Another sequence found 70 to 80 bases upstream from the start of transcription of many genes is a CXCAAT region where X may be any nucleotide.

Product gene transcription from vectors in mammalian host cells is controlled by promoters obtained from the genomes of viruses such as polyoma virus, fowlpox virus (UK 2,211,504 published 5 July 1989), adenovirus (such as Adenovirus 2), bovine papilloma virus, avian sarcoma virus, a retrovirus, hepatitis-B virus and most preferably Simian Virus 40 (SV40) or cytomegalovirus (CMV), from heterologous mammalian promoters, e.g. the actin promoter or an immunoglobulin promoter, from heat-shock promoters, and from the promoter normally associated with the product gene, provided such promoters are compatible with the host cell systems. Promoters endogenous to the host cell system, such as the CHO Elongation Factor 1 alpha promoter may also be used.

The early and late promoters of the SV40 virus are conveniently obtained as an SV40 restriction fragment that also contains the SV40 viral origin of replication. Fiers *et al.*, Nature, 273:113 (1978); Mulligan and Berg, Science, 209:1422-1427 (1980); Pavlakis *et al.*, Proc. Natl. Acad. Sci. USA, 78:7398-7402 (1981). The immediate early promoter of the human cytomegalovirus (CMV) is conveniently obtained as a *HindIII* E restriction fragment. Greenaway *et al.*, Gene, 18:355-360 (1982). A system for expressing DNA in mammalian hosts using the bovine papilloma virus as a vector is disclosed in U.S. 4,419,446. A modification of this system is described in U.S. 4,601,978. See also Gray *et al.*, Nature, 295:503-508 (1982) on expressing cDNA encoding immune interferon in monkey cells; , Reyes *et al.*, Nature, 297:598-601 (1982) on expression of human β -interferon cDNA in mouse cells under the control of a thymidine kinase promoter from herpes simplex virus, Canaani and Berg, Proc. Natl. Acad. Sci. USA, 79:5166-5170 (1982) on expression of the human interferon β 1 gene in cultured mouse and rabbit cells, and Gorman *et al.*, Proc. Natl. Acad. Sci. USA, 79:6777-6781 (1982) on expression of bacterial CAT sequences in CV-1 monkey kidney cells, chicken embryo fibroblasts, Chinese hamster ovary cells, HeLa cells, and mouse NIH-3T3 cells using the Rous sarcoma virus long terminal repeat as a promoter.

Preferably the transcriptional regulatory region in higher eukaryotes comprises an enhancer sequence. Enhancers are relatively orientation and position independent having been found 5' (Lainins *et al.*, Proc. Natl. Acad. Sci. USA, 78:993 (1981)) and 3' (Lusky *et al.*, Mol. Cell Bio., 3:1108 (1983)) to the transcription unit, within an intron (Banerji *et al.*, Cell, 33:729 (1983)) as well as within the coding sequence itself (Osborne *et al.*, Mol. Cell Bio., 4:1293 (1984)). Many enhancer sequences are now known from mammalian genes (globin, elastase, albumin, α -

fetoprotein and insulin). Typically, however, one will use an enhancer from a eukaryotic cell virus. Examples include the SV40 enhancer on the late side of the replication origin (bp 100-270), the cytomegalovirus early promoter enhancer (CMV), the polyoma enhancer on the late side of the replication origin, and adenovirus enhancers. See also Yaniv, Nature, 297:17-18 (1982) on enhancing elements for activation of eukaryotic promoters. The enhancer may be spliced into the vector at a position 5' or 3' to the product gene, but is preferably located at a site 5' from the promoter.

The DNA construct of the present invention has a transcriptional initiation site following the transcriptional regulatory region and a transcriptional termination region following the product gene (see, e.g., Figure 1). These sequences are provided in the DNA construct using techniques which are well known in the art.

The DNA construct normally forms part of an expression vector which may have other components such as an origin of replication (*i.e.*, a nucleic acid sequence that enables the vector to replicate in one or more selected host cells) and, if desired, one or more additional selectable gene(s). Construction of suitable vectors containing the desired coding and control sequences employs standard ligation techniques. Isolated plasmids or DNA fragments are cleaved, tailored, and religated in the form desired to generate the plasmids required.

Generally, in cloning vectors the origin of replication is one that enables the vector to replicate independently of the host chromosomal DNA, and includes origins of replication or autonomously replicating sequences. Such sequences are well known. The 2 μ plasmid origin of replication is suitable for yeast, and various viral origins (SV40, polyoma, adenovirus, VSV or BPV) are useful for cloning vectors in mammalian cells. Generally, the origin of replication component is not needed for mammalian expression vectors (the SV40 origin may typically be used only because it contains the early promoter).

Most expression vectors are "shuttle" vectors, *i.e.*, they are capable of replication in at least one class of organisms but can be transfected into another organism for expression. For example, a vector is cloned in *E. coli* and then the same vector is transfected into yeast or mammalian cells for expression even though it is not capable of replicating independently of the host cell chromosome.

For analysis to confirm correct sequences in plasmids constructed, plasmids from the transformants are prepared, analyzed by restriction, and/or sequenced by the method of Messing *et*

al., Nucleic Acids Res., 9:309 (1981) or by the method of Maxam *et al.*, Methods in Enzymology, 65:499 (1980).

The expression vector having the DNA construct prepared as discussed above is transformed into a eukaryotic host cell. Suitable host cells for cloning or expressing the vectors herein are yeast or higher eukaryote cells.

Eukaryotic microbes such as filamentous fungi or yeast are suitable hosts for vectors containing the product gene. *Saccharomyces cerevisiae*, or common baker's yeast, is the most commonly used among lower eukaryotic host microorganisms. However, a number of other genera, species, and strains are commonly available and useful herein, such as *S. pombe* (Beach and Nurse, Nature, 290:140 (1981)), *Kluyveromyces lactis* (Louvencourt *et al.*, J. Bacteriol., 737 (1983)), *Kyarrowia* (EP 402,226), *Pichia pastoris* (EP 183,070), *Trichoderma reesia* (EP 244,234), *Neurospora crassa* (Case *et al.*, Proc. Natl. Acad. Sci. USA, 76:5259-5263 (1979)), and *Aspergillus* hosts such as *A. nidulans* (Ballance *et al.*, Biochem. Biophys. Res. Commun., 112:284-289 (1983); Tilburn *et al.*, Gene, 26:205-221 (1983); Yelton *et al.*, Proc. Natl. Acad. Sci. USA, 81:1470-1474 (1984)) and *A. niger* (Kelly and Hynes, EMBO J., 4:475-479 (1985)).

Suitable host cells for the expression of the product gene are derived from multicellular organisms. Such host cells are capable of complex processing and glycosylation activities. In principle, any higher eukaryotic cell culture is workable, whether from vertebrate or invertebrate culture. Examples of invertebrate cells include plant and insect cells. Numerous baculoviral strains and variants and corresponding permissive insect host cells from hosts such as *Spodoptera frugiperda* (caterpillar), *Aedes aegypti* (mosquito), *Aedes albopictus* (mosquito), *Drosophila melanogaster* (fruitfly), and *Bombyx mori* host cells have been identified. See, e.g., Luckow *et al.*, Bio/Technology, 6:47-55 (1988); Miller *et al.*, in Genetic Engineering, Setlow, J.K. *et al.*, eds., Vol. 8 (Plenum Publishing, 1986), pp. 277-279; and Maeda *et al.*, Nature, 315:592-594 (1985). A variety of such viral strains are publicly available, e.g., the L-1 variant of *Autographa californica* NPV and the Bm-5 strain of *Bombyx mori* NPV, and such viruses may be used as the virus herein according to the present invention, particularly for transfection of *Spodoptera frugiperda* cells.

Plant cell cultures of cotton, corn, potato, soybean, petunia, tomato, and tobacco can be utilized as hosts. Typically, plant cells are transfected by incubation with certain strains of the bacterium *Agrobacterium tumefaciens*, which has been previously manipulated to contain the product gene. During incubation of the plant cell culture with *A. tumefaciens*, the product gene is

transferred to the plant cell host such that it is transfected, and will, under appropriate conditions, express the product gene. In addition, regulatory and signal sequences compatible with plant cells are available, such as the nopaline synthase promoter and polyadenylation signal sequences. Depicker *et al.*, J. Mol. Appl. Gen., 1:561 (1982). In addition, DNA segments isolated from the upstream region of the T-DNA 780 gene are capable of activating or increasing transcription levels of plant-expressible genes in recombinant DNA-containing plant tissue. EP 321,196 published 21 June 1989.

However, interest has been greatest in vertebrate cells, and propagation of vertebrate cells in culture (tissue culture) has become a routine procedure in recent years (Tissue Culture, Academic Press, Kruse and Patterson, editors (1973)). Examples of useful mammalian host cell lines are monkey kidney CV1 line transformed by SV40 (COS-7, ATCC CRL 1651); human embryonic kidney line (293 or 293 cells subcloned for growth in suspension culture, Graham *et al.*, J. Gen Virol., 36:59 (1977)); baby hamster kidney cells (BHK, ATCC CCL 10); Chinese hamster ovary cells/-DHFR (CHO, Urlaub and Chasin, Proc. Natl. Acad. Sci. USA, 77:4216 (1980)); dp12.CHO cells (EP 307,247 published 15 March 1989); mouse sertoli cells (TM4, Mather, Biol. Reprod., 23:243-251 (1980)); monkey kidney cells (CV1 ATCC CCL 70); African green monkey kidney cells (VERO-76, ATCC CRL-1587); human cervical carcinoma cells (HELA, ATCC CCL 2); canine kidney cells (MDCK, ATCC CCL 34); buffalo rat liver cells (BRL 3A, ATCC CRL 1442); human lung cells (W138, ATCC CCL 75); human liver cells (Hep G2, HB 8065); mouse mammary tumor (MMT 060562, ATCC CCL51); TRI cells (Mather *et al.*, Annals N.Y. Acad. Sci., 383:44-68 (1982)); MRC 5 cells; FS4 cells; and a human hepatoma line (Hep G2).

Host cells are transformed with the above-described expression or cloning vectors of this invention and cultured in conventional nutrient media modified as appropriate for inducing promoters, selecting transformants, or amplifying the genes encoding the desired sequences.

Infection with *Agrobacterium tumefaciens* is used for transformation of certain plant cells, as described by Shaw *et al.*, Gene, 23:315 (1983) and WO 89/05859 published 29 June 1989. For mammalian cells without such cell walls, the calcium phosphate precipitation method of Graham and van der Eb, Virology, 52:456-457 (1978) may be used. General aspects of mammalian cell host system transformations have been described by Axel in U.S. 4,399,216 issued 16 August 1983. Transformations into yeast are typically carried out according to the method of Van Solingen *et al.*, J. Bact., 130:946 (1977) and Hsiao *et al.*, Proc. Natl. Acad. Sci. (USA), 76:3829

(1979). However, other methods for introducing DNA into cells such as by nuclear injection or by protoplast fusion may also be used.

In preferred embodiments the DNA is introduced into the host cells using electroporation, lipofection or polyfection techniques. In a particularly preferred embodiment, the transfection is performed in a spinner vessel as illustrated by Example 3 or in some other form of suspension culture. Transfection performed in a spinner vessel is also referred to as "spinner transfection". Culturing the cells in suspension allows them to reach a cell density of at least about 5×10^5 /ml and more preferably at least about 1.5×10^6 /ml prior to transfection. See Andreason, J. Tiss. Cult. Meth., 15:56-62 (1993), for a review of electroporation techniques useful for practicing the claimed invention. It was discovered that these techniques for introducing the DNA construct into the host cells are preferable over calcium phosphate precipitation techniques insofar as the latter could cause the DNA to break up and form concatemers.

The mammalian host cells used to express the product gene herein may be cultured in a variety of media as discussed in the definitions section above. The media is formulated to provide selective nutrient conditions or a selection agent to select transformed host cells which have taken up the DNA construct (either as an intra- or extra-chromosomal element). To achieve selection of the transformed eukaryotic cells, the host cells may be grown in cell culture plates and individual colonies expressing one or both of the selectable genes (and thus the product gene) can be isolated and grown in growth medium under defined conditions. The host cells are then analyzed for transcription and/or transformation as discussed below. The culture conditions, such as temperature, pH, and the like, are those previously used with the host cell selected for expression, and will be apparent to the ordinarily skilled artisan.

Gene amplification and/or expression may be measured in a sample directly, for example, by conventional Southern blotting, Northern blotting to quantitate the transcription of mRNA (Thomas, Proc. Natl. Acad. Sci. USA, 77:5201-5205 (1980)), dot blotting (DNA or mRNA analysis), or *in situ* hybridization, using an appropriately labeled probe, based on the sequences provided herein. Various labels may be employed, most commonly radioisotopes, particularly ^{32}P . However, other techniques may also be employed, such as using biotin-modified nucleotides for introduction into a polynucleotide. The biotin then serves as the site for binding to avidin or antibodies, which may be labeled with a wide variety of labels, such as radionuclides, fluorescence, enzymes, or the like. Alternatively, antibodies may be employed that can recognize specific

duplexes, including DNA duplexes, RNA duplexes, and DNA-RNA hybrid duplexes or DNA-protein duplexes. The antibodies in turn may be labeled and the assay may be carried out where the duplex is bound to a surface, so that upon the formation of duplex on the surface, the presence of antibody bound to the duplex can be detected.

Gene expression, alternatively, may be measured by immunological methods, such as immunohistochemical staining of tissue sections and assay of cell culture or body fluids, to quantitate directly the expression of gene product. With immunohistochemical staining techniques, a cell sample is prepared, typically by dehydration and fixation, followed by reaction with labeled antibodies specific for the gene product coupled, where the labels are usually visually detectable, such as enzymatic labels, fluorescent labels, luminescent labels, and the like. A particularly sensitive staining technique suitable for use in the present invention is described by Hsu *et al.*, Am. J. Clin. Path., 75:734-738 (1980).

In the preferred embodiment protein expression is measured using ELISA as described in Example 1 herein.

The product of interest preferably is recovered from the culture medium as a secreted polypeptide, although it also may be recovered from host cell lysates when directly expressed without a secretory signal. When the product gene is expressed in a recombinant cell other than one of human origin, the product of interest is completely free of proteins or polypeptides of human origin. However, it is necessary to purify the product of interest from recombinant cell proteins or polypeptides to obtain preparations that are substantially homogeneous as to the product of interest. As a first step, the culture medium or lysate is centrifuged to remove particulate cell debris. The product of interest thereafter is purified from contaminant soluble proteins and polypeptides, for example, by fractionation on immunoaffinity or ion-exchange columns; ethanol precipitation; reverse phase HPLC; chromatography on silica or on a cation exchange resin such as DEAE; chromatofocusing; SDS-PAGE; ammonium sulfate precipitation; gel electrophoresis using, for example, Sephadex G-75; chromatography on plasminogen columns to bind the product of interest and protein A Sepharose columns to remove contaminants such as IgG.

The following examples are offered by way of illustration only and are not intended to limit the invention in any manner. All patent and literature references cited herein are expressly incorporated by reference.

EXAMPLE 1

2C4 production using the fusion construct expression vector

Vectors related to those described by Lucas et al (Lucas BK, Giere LM, DeMarco RA, Shen A, Chisholm V and Crowley C. High-level production of recombinant proteins in CHO cells using a dicistronic DHFR intron expression vector. (1996) *Nucleic Acids Res.* 24(9), 1774-1779.), which contain an intron between the SV40 promoter and enhancer and the cDNA that encodes the polypeptide of interest, were constructed. The intron is bordered on its 3' and 5' ends, respectively, by a splice donor site derived from cytomegalovirus immediate early gene (CMVIE), and a splice acceptor site from an IgG heavy chain variable region (V_H) gene (Eaton *et al.*, *Biochem.*, 25:8343 (1986)). The splice sites selected provide slightly inefficient splicing such that only about 90% of the transcripts produced are intron free. Previous studies have demonstrated that when a selectable marker such as DHFR is integrated within this intron, as in the plasmid pSV.ID, marker gene transcription proceeds from any unspliced transcripts, providing a highly efficient means of maintaining linkage between the expression of the marker gene and the cDNA of interest as well as enhanced product expression relative to expression of the marker gene.

Vectors containing a murine puromycin/DHFR fusion sequence in the intron following the SV40 promoter elements were constructed by linearizing a pSV.IPUR plasmid, which contained the puromycin resistance gene in an intron following the SV40 promoter/enhancer (pSV.IPUR, Figures 1 and 2), with Hpa I immediately following the end of the puromycin ORF. A 564 bp PCR fragment containing the entire coding region for the murine DHFR gene was subsequently ligated into this linearized vector 3' of the puromycin resistance gene. The stop codon TAG between the puromycin resistance gene and the DHFR gene was deleted by site-directed mutagenesis resulting in a pSV.I plasmid containing a Puro/DHFR fusion gene within the intron of the expression cassette (pSV.IPD, Figures 1 and 4).

The cDNA of the Heavy chain (HC) and light chain (LC) sequences of an anti-HER2 Neu antibody, 2C4, were inserted into pSV.IPD as shown in Figure 6. The sequence of the resulting pSV.IPD.2C4 vector is shown in Figure 7. Data collected using the pSV.IPD.2C4 vector are shown in Table 2.

Additionally, a vector containing only a murine DHFR sequence within the intron (pSV.ID) was prepared. The DNA sequence for the pSV.ID vector is shown in Figure 3. The preparation of such vectors is disclosed in U.S. Patent No. 5,561,053, which is herein incorporated by reference. Into that vector, the HC and LC sequences of monoclonal antibodies to VEGF were inserted. The sequence of the resulting pSV.ID.VEGF vector is shown in Figure 5.

Plasmid DNA's that contained either the Puro/DHFR fusion sequences in the intron or murine DHFR alone preceding cDNA sequences for HC and LC of 2C4 and anti-VEGF, respectively were introduced into CHO DHFR minus cells by lipofection. Briefly, for transfection, 4 million CHO DUX-B11 (DHFR minus) were seeded in 10 cm plates the day before transfection. On the day of transfection, 4 ug DNA was mixed with 300 ul of serum free medium and 25 ul of polyfect from Qiagen. The mixture was incubated at room temperature for 5 to 10 minutes and added to the cells. Cells were fed with fresh glycine, hypoxanthine and thymidine-free (GHT-free) medium and twenty-four hours later, were trypsinized and selected in fresh GHT- free medium with 0 – 5 nM of methotrexate (MTX) in order to select for stable DHFR+ clones. Approximately 300 – 400 individual clones were selected in this first round of screening for measurement of protein expression levels. Clones from each vector which expressed the highest levels of antibody were then re-exposed to higher levels of methotrexate to affect a second round of gene amplification and selection. The screening process was repeated on all available clones, the highest of which were exposed to a third round of amplification. The methotrexate concentrations used during amplification using the pSV.ID-derived vector was 50 to 1000 nM in the 2nd round and 200 to 1000 nM in the 3rd round. These concentrations are typically required to achieve growth-limiting toxicity, which is required to achieve sufficient selective pressure for gene amplification. Concentrations required to reach this same degree of toxicity using the pSV.ID-derived vectors were remarkably lower.

The level of antibody expression was determined by seeding cells in 1 ml of serum-free F12:DMEM-based media supplemented with protein hydrolysate and amino acids in 24 well dishes at 3×10^6 cells/ml or in 100 ul of similar media in individual wells of a 96 well plate. Growth media was collected after 3-4 days and titers were assayed by an ELISA directed towards the intact IgG molecule. In experiments where cells were not seeded at equal cell densities, a fluorescent measure of viable cell number was performed on each well in order to normalize expression data. An Intact IgG ELISA was performed on microtiter plates which used a capture

antisera directed to framework Fab residues common in both antibodies. Media samples were added to the wells followed by washing and a horseradish peroxidase labeled second antibody directed towards common framework Fc residues was used for detection.

Table 2 presents expression level distributions of clones isolated during each round of screening of anti VEGF clones, which resulted from transfection with the plasmid containing only the DHFR sequence in the intron (pSV.ID.aVEGF), and 2C4 clones that were created using the Puro/DHFR fusion sequence in the same intron (pSV.IPD.2C4). The distribution of expression levels seen in the case of anti VEGF is typical of the performance of the vector containing only the murine DHFR gene in the intron (pSV.ID). All isolates identified in the first and second rounds of screening have relatively low expression levels. In the initial selection round, no clones with expression above 5 were isolated. At least three rounds of amplification are required to identify clones capable of specific productivity greater than 50. The 2C4 clones were screened after the first exposure to methotrexate (0-2.5 nM) and the most productive of these were exposed to a second round of amplification in 10-25 nM MTX. Cells surviving this amplification were pooled and exposed to 3rd round amplification prior to selection for further screening. In contrast to the pSV.ID vector, using the pSV.IPD vector, clones with an expression level of up to 25 were identified even in the first round of screening. Clones with an expression level greater than 25 represented 95% of the population after their third round of amplification and screening.

The data from Example 1 indicates that use of the Puro/DHFR fusion protein as the selectable marker allows for faster, more efficient isolation of highly productive CHO clones using significantly lower levels of methotrexate. The data suggests that exposure to low concentrations and stepwise increments in methotrexate allow for the efficient initial selection of highly expressing clones and subsequent gene amplification. Exposure to excessively high concentrations of methotrexate or large incremental increases in exposure often does not yield increases in gene expression since cells rapidly acquire methotrexate resistance through non-gene amplification mechanisms. Importantly, the data also shows that the Puro/DHFR fusion protein provides an unexpectedly impaired activity of the DHFR gene product or an enhanced sensitivity to methotrexate, which results in a highly stringent initial selection step, and allows efficient gene amplification at concentrations of methotrexate not frequently associated with the acquisition of drug resistance through alternative mechanisms. The ability to select cells which have incorporated the plasmid either in the presence of puromycin or methotrexate, prior to initiating exposure to

methotrexate also provides a means of transferring this efficient system to DHFR (positive) host cells.

For Example 1 the structure of the expressed antibody has been extensively characterized. The proteins generated from the pSV.IPD are indistinguishable from the antibody produced by the pSV.ID vector, with no apparent increase of free heavy or light chain expressed by the pool.

TABLE 2. PERCENTAGES OF pSV.IPD.2C4 CLONES ISOLATED AT VARIOUS EXPRESSION LEVELS AFTER MTX EXPOSURE¹

Expression Level ²	pSV.ID.aVEGF 1st Rd	pSV.IPD.2C4 1st Rd	pSV.ID.aVEGF 3rd Rd	pSV.IPD.2C4 3rd Rd
<1	71	16	0	0
1-5	29	67	0	0
5-10	0	14	2	3
10-25	0	3	15	4
25-50	0	0	35	21
50-100	0	0	46	61
100-150	0	0	2	3

¹MTX concentration for Control SD vector = 0-10 nM 1st round, 50 –1000 nM 2nd round, 200-1000 nM, 3rd round. SD- Puro/DHFR vector = 2.5 nM 1st round, 25 nM 2nd round, 100 nM 3rd round.

² Expression levels are in mg/ml or (mg/ml)/Fluorescent Unit

This example demonstrate the general applicability of the Puro/DHFR fusion sequence for selection of highly productive recombinant cell lines following minimal exposure to MTX.

EXAMPLE 2

Recombinant protein production using a pSV.I construct containing DHFR and a fusion gene other than Puro

Constructs can also be produced that contain a fusion sequence of an alternative selectable marker and DHFR within an intron region as described in Example 1. For instance

starting with the vector pSVID, the coding sequences for the neomycin resistance gene (Neo), hygromycin resistance gene (Hygro), glutamine synthase (GS), thymidine kinase (TK) or zeocin (Zeo) could be inserted in frame with the start site of the murine DHFR sequence contained within the intron. The stop codon of this inserted gene would then be removed using site directed mutagenesis according to example 1. Depending upon the phenotype of the host cell selected, cells incorporating the plasmid could then be selected using either GHT-free or MTX containing media as described in examples 1-3 or using an appropriate quantity of the alternative selective agent. Gene expression by the resulting clones could then be amplified in the presence of increased levels of methotrexate.

EXAMPLE 3

Direct Selection with plasmids SV.IPD.HP and CMV.IPD.HP after spinner transfection

DP12 CHO cells were grown in growth medium with 5% FBS (fetal bovine serum) and 1X GHT (glycine, hypoxanthine and thymidine). The process typically took about 4 days. On day 1, cells were seeded at 4×10^5 /ml in 400 ml growth medium in a 500 ml spinner vessel and grown for 2 days at 37 °C. On day 3, the exponentially grown cells were seeded at 1.5×10^6 cells/ml in a 250 ml spinner vessel containing 200 ml of growth medium plus 5% FBS and 1X GHT. The cells were grown for 1 to 2 hours at 37 °C before transfection. During that time, serum-free growth medium and 1X GHT was warmed to 37 °C. 400 µg plasmid construct DNA and 1 ml of Lipofectamine 2000® (Qiagen) were separately diluted into 25 ml of warm serum-free medium in 50 ml Falcon tubes. The solutions in the tubes were combined and incubated at room temperature for 30 minutes. The cells were then transfected with plasmid constructs pSV.IPD.HP and pCMV.IPD.HP, which constructs are illustrated in Figures 13 and 14, respectively. At the end of incubation, the cells were transfected by adding all 50 ml of the mixture of diluted plasmid construct and Lipofectamine 2000® to the 250 ml spinner vessel containing cells in serum-free medium, and the cells continued to grow at 37 °C for about 24 hours. On day 4, 250 ml of transfected cells were centrifuged at 1000 rpm for 5 minutes to collect the pellet. The transfection efficiency was monitored by transfecting cells with a GFP plasmid followed by FACS analysis 24 hours after transfection. The transfection efficiency with this protocol was typically approximately 55 to 70 % in CHO cells as shown in Figure 8.

After the transfection, cells were centrifuged to collect the pellet. The pellet was then resuspended in growth medium containing methotrexate (MTX) ranging from 10 to 100 nM for either SV40 or CMV based constructs. Approximately 100 clones survived the direct selection. Cell growth medium was changed every 3 to 4 days. At approximately 2 weeks after transfection, individual clones were picked and grown in 96-well plates in growth medium containing MTX. Heterologous polypeptide expression levels were evaluated by ELISA. Figures 10-1, 10-2, and 11 show the results from 25 nM and 50 nM MTX selection. Figure 9 shows heterologous polypeptide expression levels of clones from a traditional 10 nM MTX selection where the cells were not transfected in a spinner flask.

It took about 1 week for cells to grow confluent in a 96-well plate. When they were confluent, the growth medium was removed and commercially available enriched cell culture medium (which includes 1x GHT but no MTX) was added into each well. On the day after adding the commercially available enriched cell culture medium, the plate was incubated at 33 °C for 5-6 days before performing an ELISA assay to quantitate the amount of humanized monoclonal antibody produced by the cells. ELISA was typically performed with serial dilutions of the commercially available enriched cell culture medium. Results from a humanized monoclonal antibody production were shown in Figures 9, 10-1, 10-2 and 11.

The four clones producing the greatest amount over 100 µg/ml of intact IgG based on direct selection at 25 nM MTX using a CMV-based construct were scaled up from a 96-well plate to a 6-well plate and then to a 10 cm plate. Cells were seeded at 3×10^5 /ml in 200 ml volume in a 250 ml spinner vessel in serum-free growth medium with 2 µg/ml human insulin and 1X Trace Elements (TE). Cells were initially passaged at either two- or three-day intervals with medium exchange. Then they were passaged at either three- or four-day intervals for about 6 weeks before bioreactor evaluation. At each passage time, cell viability and count number were monitored. To determine the cell growth after serum-free adaptation, a spinner vessel growth experiment was performed. Cells were seeded at 3×10^5 cells/ml into 400 ml of growth medium with 2 µg/ml recombinant human insulin and 1X TE in a 500 ml spinner vessel on day 1. On each day, packed cell volume (PCV) was monitored until day 5. PCVs reached between 0.4 % to 0.6% by day 4. Two serum-free adapted clones from 25 nM MTX selection with CMV-based construct were evaluated in bioreactors. Two liter bioreactors with commercially available

enriched cell culture medium were run for a total of 14 days. The data from the titer evaluation is shown in Figure 12.

An ELISA assay of clones surviving the direct selection shows that the best clones coming out of the method described in this example produce as much product of interest as highly amplified clones from a traditional method. See Figure 16. Evaluations of 2 clones from the direct selection shows that those clones produce about 1 g/L of a product of interest in a bioreactor process. Since those clones were generated from one step of a direct selection immediately after transfection, it only takes about 5 to 6 weeks to generate a stable cell line producing 1 g/L of a product of interest in a bioreactor leading to significant timeline reduction, about 3 months, which is critical for efficiency of product development.

The foregoing written specification is considered to be sufficient to enable one skilled in the art to practice the invention. The present invention is not to be limited in scope by the examples presented herein, since the exemplified embodiments are intended as illustrations of certain aspects of the invention and any functionally equivalent embodiments are within the scope of this invention. The examples presented herein are not intended as limiting the scope of the claims to the specific illustrations. Indeed, various modifications of the invention, in addition to those shown and described herein and which fall within the scope of the appended claims, may become apparent to those skilled in the art from the foregoing description.

CLAIMS

What is claimed is:

1. A method of producing a host cell capable of producing a product of interest, comprising:

transfecting a host cell culture with a DNA construct comprising a transcriptional regulatory region, a fused selectable gene sequence and a gene encoding a product of interest;

directly culturing the transfected host cells in a selective medium;

allowing the host cells to grow in the selective medium for a sufficient time to allow amplification of gene encoding the product of interest to occur; and

selecting a host cell clone that is capable of producing at least about 250mg/l of the product of interest.

2. A method of claim 1 wherein the selective medium contains at least about 25nM methotrexate.
3. A method of claim 1 wherein the selective medium contains at least about 50nM methotrexate.
4. A method of claim 1 wherein the host cell is a CHO cell.
5. A method of claim 1 wherein the product of interest is a protein selected from the group consisting of an antibody, enzyme, hormone, lipoprotein, clotting factor, anti-clotting factor, cytokine, viral antigen, chimeric protein, transport protein, regulatory protein, homing receptor, and addressin; or a fragment of said protein.
6. A method of claim 1 wherein said product of interest is a humanized antibody.
7. A host cell produced according to the method of claim 1.

8. A method of producing a product of interest, comprising culturing a host cell produced according to the method of claim 1 under conditions suitable to cause expression of the product of interest in an amount at least about 250mg/l.

9. A method of claim 1 wherein the DNA construct comprises, in order 5' to 3':

a) a transcriptional regulatory region capable of regulating transcription of both the selectable gene and the product gene;

b) a transcriptional initiation site;

c) a fused selectable gene sequence positioned within an intron defined by a 5' splice donor site comprising a splice donor sequence such that the efficiency of splicing messenger RNA having said splice donor sequence is between about 80% and 99% as determined by PCR, and a 3' splice acceptor site;

d) a product gene encoding a product of interest; and

e) a transcriptional termination site.

10. The method of claim 9 further comprising recovering the product of interest from the culture.

11. A method of claim 9 wherein the transcriptional regulatory region capable of regulating transcription of both the selectable gene and the product gene is driven by a SV40 promoter.

12. A method of claim 9 wherein the transcriptional regulatory region capable of regulating transcription of both the selectable gene and the product gene is driven by a CMV promoter.

13. A cell culture composition comprising a host cell according to claim 9 and at least about 250mg/l of the product of interest.

14. A method of producing a host cell capable of producing at least about 250mg/ml of a product of interest comprising transfecting a host cell with a DNA construct comprising in order from 5' to 3':

a) a transcriptional regulatory region capable of regulating transcription of both the selectable gene and the product gene;

b) a transcriptional initiation site;

c) a fused selectable gene sequence positioned within an intron defined by a 5' splice donor site comprising a splice donor sequence such that the efficiency of splicing messenger RNA having said splice donor sequence is between about 80% and 99% as determined by PCR, and a 3' splice acceptor cite;

d) a product gene encoding a product of interest; and

e) a transcriptional termination site;

wherein the transfection is performed in suspension culture.

15. A method of claim 14, wherein the DNA construct is introduced into the host cells by lipofection.

16. A method of claim 14 wherein said transfection is performed in a spinner vessel.

17. The method of claim 14 wherein the suspension culture has cell density of at least about 5×10^5 /ml at the time of transfection.

18. The method of claim 14 wherein the suspension culture has a cell density of at least about 1.5×10^5 /ml at the time of transfection

19. A method of claim 15 wherein the product of interest is selected from the group consisting of an antibody, enzyme, hormone, lipoprotein, clotting factor, anti-clotting factor, cytokine, viral antigen, chimeric protein, transport protein, regulatory protein, homing receptor, and addressin and a fragment of any of said product of interest.

20. A method of rapidly selecting a host cell producing a product of interest, comprising:

transfecting a host cell culture with a DNA construct comprising a transcriptional regulatory region, a fused selectable gene sequence and a gene encoding a product of interest;

directly culturing the transfected host cells in a selective medium; and

allowing the host cells to grow in the selective medium for a sufficient time to allow amplification of gene encoding the product of interest to occur.

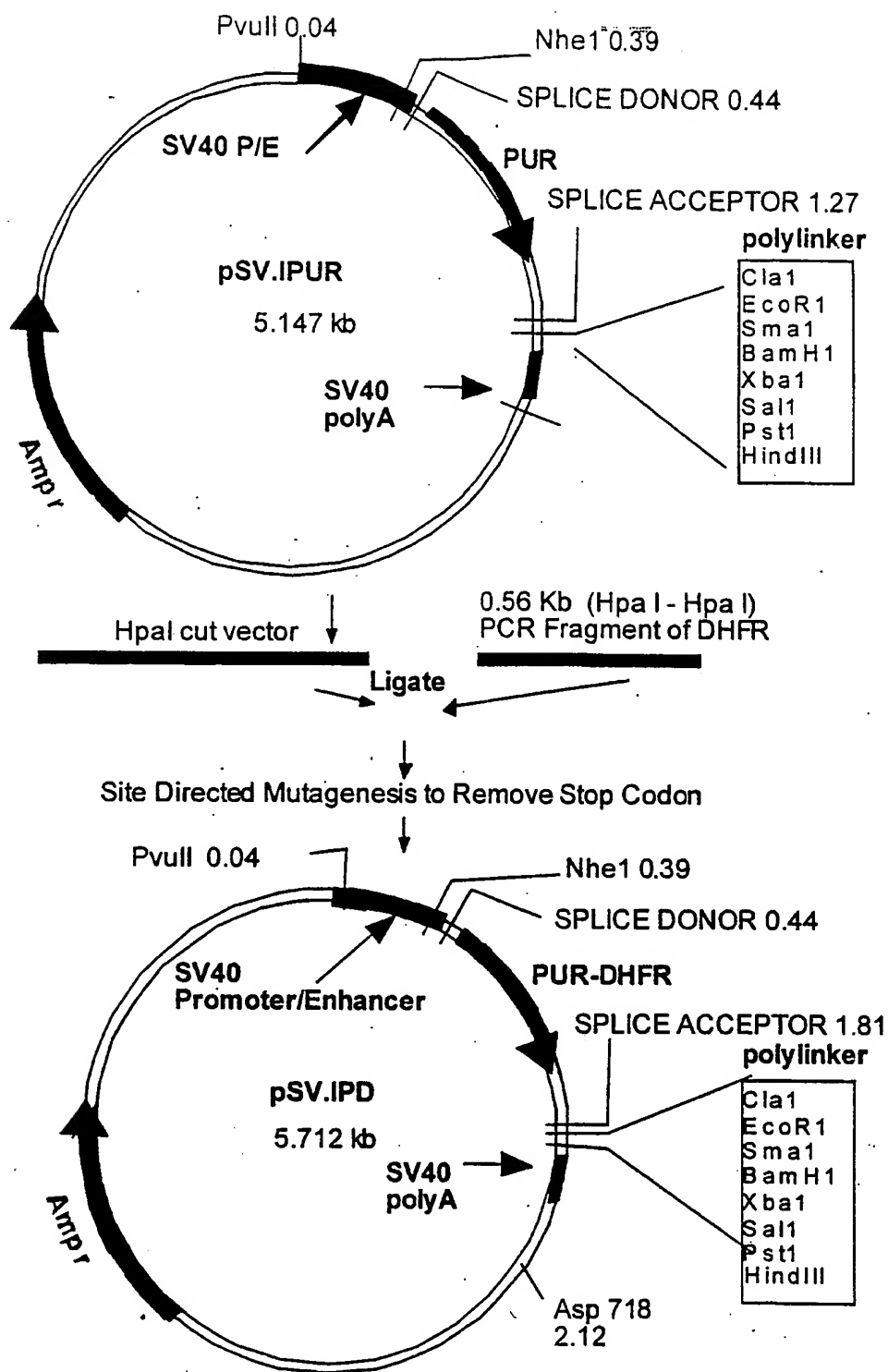


Figure 1. Construction of pSV.IPD Plasmid

Figure 2
psv.IPUR
length: 5147 (circular)

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1  TTCAGCTCG  CCCACATTTG  ATTATGACT  AGAGTCGATC  GACAGCTGTG  GAATGTGTGT  CAGTTAGGCT  GTGGAAAGTC  CCCAGCTCTC  CCACGACGAA
AAGCTCGAGC  GGGCTGTAA  TTATACTGA  TCTCAGCTAG  CTGTGACAC  CTATACACAC  GTCAATCCCA  CACCTTTCCG  GGGTCCGAG  GATTCGCTCT
101  GAAGTAGCA  AAGCATGCA  CTCATTAAGT  CAGCAACCA  GTGTGGAAG  TCCOCAGCT  CCCAGCAGG  CAGAAATAG  CAAACCATGC  ATCTCAATTA
CTTCATAGCT  TTGCTAGTA  GAGTTAATCA  GTGCTTGCT  CACACCTTC  AGGGTCGGA  GGGTCTGCT  GTCTTCATAC  GTTTCGTAG  TAGAGTTAAT
201  GTCAGCAAC  ATAGTCCCG  CCCTACTCC  GCGUATCCG  CCGCTAACT  CGCCAGTTC  CGCCCATTT  CCGCCCCATG  GCTGACTAAT  TTTTTTTAT
CAGTCGTGG  TATCAGGGG  GGGATTGAG  GGGGTGAGG  GCGGTCAAG  GCGGTCAAG  GCGGTCAAG  GCGGTCAAG  GCGGTCAAG  GCGGTCAAG
301  TATGACAGG  CCGAGGCGG  CTCGGCTCT  GAGCTATTCC  AGAAGTAGT  AGGAGGCTT  TTTGAGGCT  TAGGCTTTT  CAAAAGCTTA  GCTTATCTCC
ATACGTCTCC  CGCTCGGG  GAGCGGAGA  CTCGATAAG  TCTTCATCA  TCCTCGAAG  ARACTCCGG  ATCCGAAAC  GTTTTTCGAT  CGAATAGGCG
401  CCGGAAACG  TGCATTGGA  CCGGATTCC  CCGTGCAAG  AGTGACCTA  GTACCGCTA  TAGAGGACT  AGTCCACCAT  GACCGAGTAC  AAGCCGAGG
GGCCCTTGC  ACGTAACCT  GGGCTAAGG  GGCACGGTT  TCATGCTAT  CATGGCGAT  ATCTCGTGA  TCATCTGTA  CTGGCTCAT  TTCTGCTGCT
501  TCGGCTCG  CACCCCGAC  GACCTCCCG  GGGCCGTAC  CACCTCGC  CGCGCTTC  CCGACTACC  GGCACGCGC  CACACCTTC  AAGCCGAGG
ACCGGAGCG  GTGGGCGCT  CTCAGGGGG  CCGGCGATG  GTGGAGCG  GCGGCAAG  GGTGTAGG  GCGGTGCG  GTGTGCGC  TCGGCTGCT
601  CCACATCG  CGGTCACCG  AGCTGCAGA  ACTCTCTCT  TGAAGAGG  TGGCGGAG  CCGAGTCT  GCGGTCTCA  ACCCAGCG  TGCTCCCG  GCGGCTGCT
GGTGTAGCT  GCGGCTCT  GCAGCTTGC  CCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT
701  GTCTGACCA  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG
CAGACTGCT  GCGGCTCT  GCAGCTTGC  CCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT
801  AGATGGAAG  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG  CCGCGAGAG
TCTACTTCC  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT
901  CCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT
GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT
1001  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT
GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT
1101  CCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT
GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT
1201  CCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT
GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT
1301  CCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT
GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT  GCGGCTCT

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Figure 2-1

1401 CATCACAAAT TTCACAATA AACATTTTT TTCACCTGCAT TCTAGTTGTG GTTGTCCAA ACATCATCAAT GTATCTTATC ATGCTGTGGAT CUATCUGHAA
 GTAGTGTTTA AAGTGTTTAT TTCTGTAATA AAGTAGCGTA AGATCAACAC CAACACAGTT TGAGTAGTTA CATAGAATAG TACAGACCTA CTATGCCCTT

 1501 TTAATTCGGC GCAGCACCAAT GGCCTGAAAT AACCTCTGAA AGAGGAACCTT GGTAGGTAC CTCTGAGGC GGAAGAACC AGCTGTGAA TGTGTCTCAG
 AATTAAGCGC CGTCGTGGTA CCGGACTTTA TTGGAGACTT TCTCCTTGAA CCAATCCATG GAAGACTCCG CCTTCTCTGG TCGACACCTT ACACACATC

 1601 TTAGGCTGTG GAAAGTCCCC AGGCTCCCA GCAGGCAGAA STATCBAAG CATGATCTC AATTAGTCAG CAACACAGTG TGAAGAATCC CCAGGCTCCC
 AATCCACAC CTTTCAGGGG TCCGAGGGGT CCGCTCTT CATACGTTTCTT GTAGCTAGAG TTAATCAGTC GTTGTGCAC ACCTTTACAG GGTCCGAGGG

 1701 CAGCAGGCAG AAGTATGCAA AGCATGCATC TCAATTAGTC AGCAACATA GTCCCGCCC TAACTCCGC CATCCCGCC CTAACCTCUC CCAGTTCCGC
 GTCTCCGTC TTATACGTT TCGTAGGTAG AGTTATCAG TCGTTGAT CAGGCGGGG ATTGAGCGGG GTAGGCGGG GATTGAGGG GGTCAAGGCG

 1801 CCATTCTCG CCCATGGCT GACTAATTTT TTTTATTTAT SCAGAGCGCG AGCCCGCTC GGCCTCTGAG CTATTCAGA ACTAGTGAGG AUGCTTTT
 GGTAAAGGC GGGTACCGA CTGATTAATA AATAAATA CGTCTCCGC TCGGCGGAG CCGGAGACTC GATAAGTCT TCATCACTCC TCCGAAAAA

 1901 GGAGGCTAG GCTTTTGCAA AAAGCTGTTA CCTCGAGCG CGCTTAAT AAGGCGCGC ATTTAATCC TGCAGTAAAC AGCTTGGCAG TGGCTCTCTG
 CCTCGGATC CGAAACGTT TTTCGACAAAT GGAGCTCGCC GCGGAATTA TTCCGCGGG TAAATTTAGG ACGTTCATTG TCGAACCTG ACCGCAACA

 2001 TTTCAACGT CGTACTGGG AAAACCTGG CGTTACCCAA CTTAATCGCC TTGCAGACA TCCCCCTTC GCCAGCTGG GTRATAGCA ACAGGCGG
 AATGTTGCA GCATGACCC TTTTGGACC GCAATGGGTT GAATAGCGG AAGTCTGT AGGGGGAAG CCGTCAACG CATTTACCT TCTCCGCGG

 2101 ACCGATCGC CTTCACAA GTTGGTAGC CTGAATGGG AATGGGCTT GATGCGTAT TTTCTCCTTA CGCATCTGT CGTATTTC CACUUCATAC
 TGGTAGCGG GAAGGTTGT CAACGATCG GACTTACCG CTACGCCAAT AAGAGGAAT CGGTAGACAC GCCATAAGI GTGGGTATG

 2201 GTCAAGCAA CCATAGTAG CGCCCTGTAG CGGCGCATTA AGCGGCGG GTGTGTGTGT TAGCGCGAGC GTACCCCTA CACTTGGCAG CCGCTTAGG
 CAGTTTCGT GGTATCATGC GCGGACATC GCGGCTAAT TCGGCGGCG CACACACCA ATGCGGCTG CACTTGGCAT GTGAACGTC GCGGATGCG

 2301 CCGGCTCCTT TCGTTTCTT CCCTTCTT CCGGACGT TCGCGGCTT TCCCTCAA GCTCTAAATC GGGGGTCCC TTTAGGGTTC GATTTTACTG
 GGGCGGGAA AGCGAAGAA GCGAGGAA GAGCGGTGCA AGCGGCGGAA AGGGGCGATT CGAGATTAG CCCCCGAGG AATCCCAA GCTAAATCAC

 2401 CTTTACGCA CCTCGACCC AAAAATCTG ATTTGGTGA TGGTTCACGT AGTGGGCCAT CGCCCTGATA GAGGTTTTT CGCCCTTGA COTTTGAGT
 GAAATGCGCT GGAGCTGGG TTTTGTGAAC TAAACCACT ACCAAGTGA TCACCCGCTA GCGGGACTAT CTGCCAAAA GCGGAAACT GCAACCTCAG

 2501 CAGCTTCTT NATAGTGAC TCTGTTCOA AACTCGACA ACATCAACG CTATCTCGG CTATCTCTT GATTTATAAG GATTTTGGC GATTTGGGC
 GTGCAAGAA TTATCACCTG AGACAAGGT TTGACCTTGT TGTGAGTTG GATAGGCC GATAAGAAA CTAAATATTC CCTTAAACGG CTAAAGGCG

 2601 TATTGGTTAA AAAATGAGCT GATTTAACAA AAATTTAAG CGAATTTAA CAAATATTA CAAATATTA TTTTATGGT CACTCTCAGT ACATCTCTG
 ATACCAAT TTTTACTGA CTAAATGTT TTTTAAATG CTTTAAAT GTTTTATAAT TCGAATGTT AATATACCAC GTGAGAGTCA TGTTAGAGCA

 2701 CTGATGCGC ATAGTTAAG CAATCTCGCT ATCGTACGT GACTGGTCA TGGCTCGGC CCGACACCG CCAACACCG GTGAGCGGC CTUACCGCT
 GACTACGCG TATCAATTC GTTACGCGA TAGCATGCA CTGACCCACT ACCGAGCGG GCGTGTGGG GGTGTGGG GACTGCGCG GACTGCGCG

 2801 TGTCTGTCC CGGCATCCG TTACAGCAA GCTGTGACG TCTCGGGAG CTGATGTGT CAGAGGTTTT CACCGTCAAT ACCGAAACG GUAUAGUACT
 ACAGACGAG GCGGTAGCG AATCTCTCTT CGACACTGCG AGAGCCCTC GAOTACACA GTCTCCAAA GTGCGAGTAG TGGCTTTGCG CCGTCTCTA

 2901 ATCTTTGAG ACGAAGGGC CTCGTGATAC GCCTATTTT ATAGGTTAT GTCATGATAA TAATGTTTT TTAGAGTCA GGTUAGACTT TTCTATTAATA
 TAAGAACTTC TGTCTTCCG GAGCACTATG CGGATAAAA TATCCAATA CAGTACTAT ATTACCAAG AATCTCAAT CCACTCTCA AAGUCTTTT

 3001 TGTGCGGGA ACCCTATTT GTTTATTTT CTAAATACAT TCAATATGT ATCCGCTCAT GAGACAATAA CCTGTATAA TGTCTCAATA ATATTCAAAA

Figure 2-2

ACACGGCCCT TGGGGATRAA CAAATRAAAA GATTTATGTA AGTTTATACA TAGGCGACTA CTCGTATTAT GGCACATATT GCGACATTTT TATTAACATTTT
 3101 AGGAAGAGTA TGAGTATTCA AGATTTCCGT GTCCGCCCTTA TTCCCTTTT TGCSCATTT TGCCTTCTCG TTTTCTCTCA CCCAGAAAAC CTGCTGAAAG
 TCCTTCTCAT ACTCATAGT TGTAAAGCA CAGCGGGAAT NAGGGJNAAA ACGCGTAAA ACGGAAGAGT AAAACAGAGT GGGTCTTTCC GACCACTTTC
 3201 TAAAGATGC TGAAGATCAG TTGGGTGCAC GAGTGGGTTA CAGCGAATG GATCTCAACA GCGGTAAGAT CCGTAGAGT TTTCCGCCCG AAGAAGCTTT
 ATTTCTACG ACTTCTAGT AACCCAGTG CTCACCAAT STAGCTGAC CTAGAGTGT CGCATCTTA CGCATCTCA AAAGCGGJJC TTTCTTCCAAA
 3301 TCCATGATG AGCACTTTTA AAGTCTGCT ATGTGGGCG GTATTATCC GTGATGAGC GGGCAAGAG CAACTGGTTC GGTGAGCCAG CCGGCTTCTC GATATCTCAG
 AGTTACTAC TGTGAAAAT TTCAAGACA TACACCGCGC CATAATAGG CACTACTCG GCGGTCTC CATGAGCCAG CCGGCTTCTC GATATCTCAG CTAATCTCAG
 3401 ATGRCCTTGG TTGATGACTC ACCAGTCACA GAAAGCATC TTACGATGG CATGACAGTA AGAATTTAT GCATCTTATA CBTACGAGC GTATTGCTAC TCACATTTT
 TTACTGAACC AACTCATGNG TGTTCAGTGT CTTTTCGTAG AATGCTACC GTACTGTAT TCTCTTATA CBTACGAGC GTATTGCTAC TCACATTTT
 3501 CTGCGGCCAA CTTACTTCTG ACACGATCG GAGGACCGAA GAGGCTTCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG
 GAGCGCGGT GAATCAAGAC TGTTCGTAG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG
 3601 ACCGAGCTG ATGAAGCCA TACCAACGA CGAGCTGCTG ACCAGATGC CAGCAGCAAT GGCACAAAC TTGCGCAAC TATTAAUTGG CAACTATTT
 TGGCTTGCAC TTACTTCTG ATGCTTCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG
 3701 ACTCTAGCT CCCGCAACA ATTAATAGC TGGATGAGG CCGATTAAGT TGCAGGACA CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG
 TGAGATCGAA GGGCGTGT TAATTATCTG ACCTACTCG CCGATTAAGT TGCAGGACA CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG
 3801 ATATATCTG ACCCGTCTG CCGGATCTG TGCAGGACA CCGATTAAGT TGCAGGACA CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG
 TATTAGACC TCGGCACTC CCGCAGAG CCGCAGTGA ACCTGCTG CCGATTAAGT TGCAGGACA CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG
 3901 TCGGCACTC CCGCAGAG CCGCAGTGA ACCTGCTG CCGATTAAGT TGCAGGACA CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG
 AGTCTGCTG TACTTCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG
 4001 TATATGAT TAACTTCA TTTTAAATTT AAGGATCT AGGTGAGT CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG
 ATCTACTAA ATTTGAAT ANAATTAAT TTTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG
 4101 ACTGAGCTC AGCCCGCTA GAAAGATCA AAGGATCT TCGATCTG TTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG
 TGAATCTGCTG TCTGCGGCT CTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG
 4201 AGCGGTGTT TGTTCGCG ATCAGAGCT ACCAATCT TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG
 TCGCCACCA ACAAAGGCT TAGTCTGTA TGTCTGTA TGTCTGTA TGTCTGTA TGTCTGTA TGTCTGTA TGTCTGTA TGTCTGTA TGTCTGTA
 4301 CCGTATGAG GCGACACTT CAGGACTCT GTAGCAGCT CTACATACCT CCGTCTGCTA ATCTGCTG CCGTCTGCTA ATCTGCTG CCGTCTGCTA ATCTGCTG
 GGCATCAAT CCGTCTGCTA ATCTGCTG CCGTCTGCTA ATCTGCTG CCGTCTGCTA ATCTGCTG CCGTCTGCTA ATCTGCTG CCGTCTGCTA ATCTGCTG
 4401 GTCTTACCG GTTGGACTC AGAGATAGT TACCGGATTA GCGCGGCTG TCGGCGGCTG CCGCGGCTG TCGGCGGCTG CCGCGGCTG TCGGCGGCTG
 CAGATGCTC CAACCTGAGT TGTGCTATCA ATGCGCTAT ATGCGCTAT ATGCGCTAT ATGCGCTAT ATGCGCTAT ATGCGCTAT ATGCGCTAT ATGCGCTAT
 4501 CTACACGGA CTGAGTACC TACAGGCTGA GCATTGAGA AGCGGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG
 GATGTGCTT GACTCTATG ATGCTGCTT CTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG TTTCTGCTG
 4601 ACAGGAGC GCAGAGGGA GCTTCCAGG GCAACGCTT GATCTCTT TATGCTCTG TATGCTCTG TATGCTCTG TATGCTCTG TATGCTCTG TATGCTCTG
 TGTCTCTG CCGTCTGCT CCGAAGTCT CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG CTTCTGCTG
 4701 GCTCTCTAG GGGCGGAG CTATGAGAA ACGCCAGAA CCGGCTTCTG TATGCTCTG TATGCTCTG TATGCTCTG TATGCTCTG TATGCTCTG TATGCTCTG
 CCGAGCTCT CCGGCTCTG GATACCTTT TGGGCTGTT TGGGCTGTT TGGGCTGTT TGGGCTGTT TGGGCTGTT TGGGCTGTT TGGGCTGTT TGGGCTGTT

Figure 2-3

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4801 GTTATCCCCT GATTCTGTGG ATAACCGTAT TACCGCCTTT GAGTGAGCTG ATACCGCTCG CCGCAGCCGA ACGACCGAGC GCAGCGAGTC ACTGAGCGAG  
CAATAGGGGA CTAAGACACC TATTGGCATA ATGGCGAAA CTCACCTGAC TATGGCGAGC GCGTCGGCT TGCTGGCTCG CGTCGCTCAG TCACTCGCTC  
4901 GAAGCGGAAG AGCGCCCAAT ACGCAACCG CCTCTCCCCG CGCGTTGGCC GATTCAATAA TCCAGCTGGC ACGACAGGTT TCCCGACTGG AAAGCGGGA  
CTTCGCCCTTC TCGCGGGTTA TCGGTTTGGC GGAGAGGGGC GCGCAACCGG CTAAGTAATT AGGTCGACCG TGCTGTCCAA AGGGCTGACC TTTCGCCCTT  
5001 GTGAGCGCAA CGCAATTAAT GTGAGTTACC TCACTCAATTA GGCACCCAG GCTTTACACT TTATGCTTCC GGCTCGTATG TTGTGTGGAA TTGTGAGCGG  
CACTCGCGTT GGGTTAATTA CACTCAATGG AGTGAGTAAT CCGTGGGTC CGAATGTGA AATACGAAG CCGAGCATAC AACACACCTT AACACTCUCG  
TATTGTTAAA GTGTGTCCTT TGTCGTACT GGTACTAATG CTTAATT
```

>length: 5147

Figure 2-4

Figure 3
PSV.ID
length: 5171 (circular)

1 TTCGAGCTCG CCCGACATGG ATTATTGACT AGAGTCGATC GACAGTCGIG GAATGTGTGT CAGTTAGGGT GTGGAAGTC CCCAGGCTCC CCACGAGGUA
 AAGCTCGAGC GGGCTGTAC TAATAACTGA TCTCAGCTAG CTGTGACAC GTTACACACA GTCAATCCCA CACCTTTCAG GGGTCCGAGG GGTCTGTCCT
 101 GAAGTATGCA AAGCATGCA CTCAATTAGT CAGCAACACAG GTGTGGAAG TCCCCAGGCT CCCAGCAGG CAGAAGTATG CAAAGCATTC ATCTCTAATTA
 CTTCATACGT TTCGTACGTA GAGTTAATCA GTCTGTGGTC CACACCTTTC AGGGGTCCGA GGGGTCTGTC GTCTTCATAC GTTTCGTAGG TAGAATTAAT
 201 GTCAACAACC ATAGTCCCGC CCCTAACTCC GGCCTATCCG CCCTAACTC CGCCACAGTTC CGCCCATTTCT CGCCCCCATG CCTCACAATAT TTCTTTTATAT
 CAGTCGTTGG TATCAGGGGG GGGATTGAG GGGGTAGGG GGGGATTGAG GGGGTCAAG GCGGGGTAC CGACTGATTA AAAAAATAA
 301 TATCAGAGG CCGAGGCGGC CTCGGCTCT GAGCTATTCC AGAAGTAGTG AGGAGGCTTT TTGAGAGGC TAGGCTTTTG CAAAAAGCTA GCTTATATCCG
 ATACGTCTCC GGTCCGGGG GAGCCGGAGA CTCGATAAGG TCTTCATCAC TCTCCGAAA AACCTCCGG ATCCGAAAAC GTTTTTCGAT CGAATAGGCG
 401 CCGGGAACGG TGCATTGGAA CGCGGATTC CCGTGCCAG AGTGAGCTAA GTACGCCCTA TAGAGTCTAT AGGCCACCC CTTCGGCTTA CAGAGATATA
 GGCCTTTCGC ACGTAACTTT GCGCCTAAGG GGCACGGTTC *splice donor
 501 AGCCTAGGAT TTTATCCCG GTGCCATCAT GTTCGACCA TTGAAGTGA TCGTCGCCGT GTCCCCAAAT ATGGGAGTGG GCAAGAAAGG AGACTATATAT
 TCGGATCCTA AATAGGGGC CAGGTAGTA CCAAGTGTGT TAATTGACGT AGCAGCGGCA CAGGTTTTTA TACCCCTAAC CGTCTTACC TCTGATTCGG
 601 TGCCCTCCGC TCAGGAACGC GTTCAAGTAC TTCCAAAGAA TGACACACAC CTCTTCAGTG GAAGGTAAAC AGAATCTGGT GATTATGGGT AUAJAAAACTT
 AGGGAGGGG AGTCTTTCG CAAGTTTCAT AAGGTTTCTT ACTGGTGTG GAGAAGTCA CTTCCATTGG TCTTAGACCA CTAATACUCA TCTTTTTCGA
 701 GGTCTCCAT TCCTGAGAG AATCGACCTT TAAGGACAG AATTAATATA GTTCTCAGTA GAGAACTCAA AGAACCAACA CGAGGAGCTC ATTTTCTTCA
 CCAAGAGGTA AGGACTCTTC TTAGCTGGAA ATTTCTGTCT TTAATATAT CAGAGTCAAT CTCTGAGTT TCTTGGTGGT GCTCCTCCAG TAAAGAAAGG
 801 CAAAGTTTG GATGATGCT TAAGACTTAT TGAACAACG GAATTTGGCA GTAAAGTAGA CATGTTTGG ATAGTCGGAG GCAGTCTCTGT TTACACAGAA
 GTTTTCAAA CTACTACGA ATCTGAAATA ACTTGTGGC CTTAACCGTT CATTTCACTGT GTACCAAAAC TATCAGCTC CGTCAAGACA AATGCTCTCT
 901 GCAATGATC AACCAAGGCA CCTAGACTC TTTGTGACAA GATCATGCA GGAATTTGAA AGTGACACGT TTTTCCAGA AATTGATTTG GGGAAATATA
 CGGTACTTAG TTGTCCGGT GGAATCTGAG AACACTGTT CTTAAGCTT TCACTGTGCA AAAAGGCTCT TTAACATAAC CTTTATATAT
 1001 AACCTCTCCC AGAATACCA GCGTCTCTCT CTGAGGTGCA GGAGGAAA GGCATCAAGT ATAAGTTTGA AGTCTAGGAG AAGAAAGACT AUAAGAGAA
 TTGGAGAGG TCTTATGGT CCGCAGGAGA GACTCCAGT CTTCTTTT CCGTAGTTCA TATTCANAAT TCAGATGCTC TTCTTCTCTA TTCTCTCTCT
 1101 TGCTTTCAAG TTCTCTGCT CCCTCCCTAAA GCTATGCAAT TTTATAGAC CATGGACTTT TTGCTGGCTT TAGACCCCTT AGAACGGAJ
 ACGAAGGTC AAGAGACGAG GGGAGGATT CGATACGTAA AATATTCTG GTACCTGAA AACGACCGAA ATCTGGGGA ACCTGAAGCAA TCTTTGCGGCG
 1201 TACAATTAAT ACATACCTTT ATGTATCATA CACATAGATT TAGGTGACAC TATAGATAA CATCCACTTT GCTTTTCTCT CCACAGTGT CATTTAAT
 ATGTTAATTA TGTATTGGAA TACATAGTAT GTGTATCTTA ATCCACTGTG ATATCTTAT GTAGGTGAAA CCGAAGAGAG GTTGTUACA GTTAGGTTCA
 1301 CAAGTGCACC TCGGTTCTAT GATTTGAAT CCGCGGGAT CTTCTAGACT GACCTGAC AGCTTTGGC GCTCATGGCC AACCTTCTTTA TTCTACCTTA
 GTTGACGTGG AGCAAGATA GCTAACTTAA GGGGCCCTTA GGAGATCTCA GGTGACGTC TTCCGAACCG GGTACCGG TTCAACAAAT AACCTTCAAT
 1401 TAATGGTTAC AATAAAGCA ATAGCATCAC AATTTTACA AATAAGCAT TTTTTCACAT TCTGTTTCTT TCTGTTTCTT CCAATCTAAT CATCTTATAT

Figure 3-1

ATTACCAATG TTTATTTCTG TATCTAGTG TTTAAAGTGT TTAATTCGTA AAAAAAGTGA COTRAGATCA ACACCAANCA GGT'TTGAGTA GTTATACATAGA
 1501 TATCATGTCT GGATCGATCG CCAATTAATTT CGGCGCAGCA CCATGCGCTG AATATACCTTC TGAAGAGGGA ACTTGTGTAG GTACCTTCTG AGGCGGAAAG
 ATAGTACAGA CCTAGCTAGC CCTTAATTA GCGCGTCTGT GGTACCGGAC TTTATTTGGAG ACTTTCCTCT TGAACCAATC CATGGAAGAC TCCGCTTCTC
 1601 AACGAGCTGT GGAATGTGTG TCAGTTAGGG TGTGAAAGT CCCAGGGCTC CCCAGAGGCG AGAAGTATGC AAGCATGCA TCTCAATTAG TCACCAALCA
 TTGCTCGACA CCTTACACAC AGTCAATCCC AACCTTTCA GGGTCCGAG GGGTCTCGG TCTTCATACG TTTCTACGT AGAGTTAATC AATGTTTGT
 1701 GGTGTGAAA GTCCCGAGG GTCCAGCAG GCRAGAGTAT GCAAGCATG CATCTCAAT ACTCAGCAAC CATAGTCCG CCCCTAATC CCCCCATCTC
 CCACACCTTT CAGGGTCCG AGGGTCTGTC CGTCTTCATA CGTTTCGTAC GTAGAGTTAA TCAGTCTGTG GTATCAGGCG GGGGATTGAG GUGGATGAG
 1801 CCGCTTAAT CGGCCAGTT CGGCCCAT TCGCCCATTC TCCGCCCAT GGTGACTTAA TTTT'TTAT TTATCGAGAG GCCGAGGCG CCTCGGCTC TGAGCTWATTC
 CGGGATTGA GCGGGTCAA GCGGGTTRAG AGGCGGGA CCGACTGAT AAAAAAATA AATACGTCTC CCGCTCCGC GGAGCCGAG ACTCGATAAG
 1901 CAGAGTATGT GAGGAGGCTT TTTTGGAGG CTAGGCTTTT GCAAAAGCT GTTACTCGA CCGCGCGCTT AATTAAGGCG COCCATTTAA ATCTTGCAAG
 GTCTTCATCA CTCCTCCGA AARACCTCG GATCCGAAA CTTTTTTCGA CAATGGAGCT CCGCGCGGAA TTAATTCGC GCGTAAAT TAGGACCTTC
 2001 TAACAGCTG GCACTGCGG TGT'TTTTACA AGTCTGTGAC TGGGAAAC CCCTGCTTAC CCACTTAAT CCGCTTGCAG CACATCCGCC CTTCGCCAUC
 ATTGTGAAAC CCGTACCGGC AGCAAAATGT TGCAGCACTG ACCCTTTGG GACCGCAATG GGTTCNATTA CCGGAACGTC GTGTAGGGGG GAAGCGGTG
 2101 TGGCGTAATA GGAAGAGG CCGCACCGAT CGCCCTTCC AACAGTTCCG TAGCTGAAT GGCATGCG CCTCATGCG GTATTTTCTC CTTACGATAC
 ACGCATAT CGCTTCTCG GCGTGCTA GCGGGAAGG TTGTCAACG ATCGACTTA CCGCTTACG CCGACTACG CATAAAGAG GAATGCTAG
 2201 TGTGCGTAT TACACACCG ATAGTCAAAA GCAACCATAG TAGCGGCTT GATGCGCTT ATTAAGCGG CCGGTGTG TGGTTACGCG CAKCTHJAK
 ACAGGCCATA AGTGTGGG TATGCACTTT CGTTGTATC ATGCGCGGGA CATGCGCGG TAATTCGCG CCGCCACACC ACCAATGCG GTGCACTG
 2301 GCTACACTTG CCAGCGGCT AGCGCGCT CTCTTCCCTT TCTTCCCTC CTCTTCCGCG AGTTCGCGG TCAAGGCGG CAAAGGCGG AGTTGCGAT TTAGCGGCG
 CGATGTGAC CCGCGGCGA TCGCGGCGA GGAAGCGAA AGAAGGGAAG GAAAGCGG TAATTCGCG CCGCCACACC ACCAATGCG GTGCACTG
 2401 TCCCTTTAGG GTTCCGATTT AGTGTCTTAC GGCACCTCGA CCGCAAAA CTTGATTTGG GTGATGTTG ACCTAGTGG CCATGCGCT CATAGALCT
 AGGGAATCC CAAGCTTAA TCAGGAATG CCGTGAGCT GGGTTTTTTT GAACATAACC CACTACCAAG TGCATCACC GGTAGCGGGA CTATCTGCGA
 2501 TTTTCCCTT TTGACCTTG AGTCCAGCTT CTTTATATG GACTCTGT TCCAAACTG AACCAACTC AACCTATCT CGGCTATTC TTTTCAATTA
 AAAGCGGA AACTGCAAC PCAGGTGCAA GAATTTATCA CCTGAGAAC AGTTTTGACC TTGTGTGAG TTGGGATAGA CCGCATAG AACTTAAAT
 2601 TAAGGATTT TCCGATTTT GGCCTATTG TTAATAATG AGCTGATTTA ACAAATTTT AACCGCAAT TTAACAAAT ATTACGTTT ACATTTTAT
 ATTCCCTAAA ACGGCTAAG CCGGATAAC MATTTTAT TCGACTAAT TGT'TTTTAA TTCCGCTTAA AATTGTTTA TAATGCAAA TGT'TAAAAA
 2701 GGTGACTCT CAGTACAATC TGCTCTGATG CCGCATAGTT AAGCCTACT CCGTATCGCT ACCTGACTGG GTCATGCGTG CGCCCCGACA CCGCCCAACA
 CCACGTAGA GTCATGTTAG ACGAGACTAC GCGTATCAA TTCCGTTGAG GCGATAGCGA TCGACTGACC CAGTACGCG CCGGGGCTGT GGGCGGTTGT
 2801 CCGCTGAG CCGCTGAG GGTGTCTG CTCCCGCAT CCGCTTACAG ACAAGCTGT CCGCTCTCG GAGCTGCTAT GTGTGAGG TTTTCAATTA
 GGGGACTGC CCGGACTGC CCGACAGAC GAGGCGGTA GCGGATGTC TGTTCACAC TCGCAGGCG CCGGAGGCT CACAGTCTCC AAAAGTGGCA
 2901 CATACCCGAA ACGCGGAGG CAGTATCTT GAAGACGAA GGGCTCTG ATAGCTAT TTTTATAGT TTAATGATG ATAAATATG TTTTCTTATAC
 GTAGTGGCTT TCGCGCTCC GTCAAGAA CTCTGCTT CCGGAGGAC TATGCGGATA AAAATATCCA ATTACAGTAC TATTAATACC AAAGAATCTG
 3001 GTCAGGTGCG ACTTTTCGG GAATGTGG CCGRACCTCT ATTTGTTTAT TTTTCTAAT ACATCAAT ATGTATCCG TCATGAGACA ATAACTTGA
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 3101 TAAATGCTTC AATATATTG AAAAGGAG AGTAGATA TTCAATTT CCGTGTGCG CTATTTCCCT TTTTCCGCG AATTAAGGGA AAAACGCGG TAAACGGA GGAACAAAC
 ATTTACGAG TATTATAAC TTTTCTTC TCATACTCT AAGTTGTAAA GGCACGCGG GAATPAAGGA AAAACGCGG TAAACGGA GGAACAAAC

Figure 3-2

3201 CTCACCCAGA ACGCTGGTG ARAATRAAG ATGCTERAGA TCAGTTGGGT GCACGAGTGG GTTACANTCGA ACTGATCTC AACAGGGTGA AGATCTCTGA
 GAGTGGTCT TTGGGACCAC TTTCATTTTC TAGGACTTCT AGTCARCCCA CGTCTCACC CAATGTAGCT TGACCTAGAG TTGTGCCAT TCTAGGAAC
 3301 GAGTTTTCCG CCGAAGAAC GTTTTCCAAT GATGAGACT TTTAAAGTTC TGTATGTGG CGCGTATTA TCCGTGATG ACGUGGGA AGAGCAACTC
 CTCARAAGCG GGGCTTCTTG CAAAGGTTA CTACTCTGA AATTTTCAAG ACGATACACC CGGCATTAAT AGGCCTATAC TCGGCCCCGT TCTCTGTGAG
 3401 GGTGCGCGCA TACACTATTC TCAGATGAC TTGGTTGAGT ACTCACCACT TGTAGTGTCA GTGCTTTTC CATCTTACCG ATGGCATGAC AGTAAGAGAA TTATCCAGT
 CCAGCGCGGT ATGTGATAAG AGCTTACTG ACCCACTCA TGAGTGTGCA GTGCTTTTC CATCTTACCG ATGGCATGAC AGTAAGAGAA TTATCCAGT
 3501 CTGCCATTAAC CATGAGTAT AACTCTGCGG CCAACTTACT TCTGACHACG ATCGAGGAC CGAAGGAGCT AACCGCTTT TTGCACAACA TGGGCTATCA
 GACGGTATTG GTACTCACTA TTGTGAGCGC GGTGGAAGA AGACTGTGCA GGTCTCTG TAGGCTCTGA TTGGGAAAA AACGTGTGT ACCCCGTAGT
 3601 TGTAACTCGC CTTGATCGTT GGAAGCGGA GCTGAATGAA GCCATACCAA ACGACGAGCG TGCATGCTGC ACTGTGTGC TACGGTCTGC GTTACCGTTG TTGCAACGGG
 ACATTGAGCG GAATGACAA CCGTGGCGCT CGACTTACTT CGGTATGGTT TGTGCTGCG ACTGTGTGC TACGGTCTGC GTTACCGTTG TTGCAACGGG
 3701 AACTATTAA CTGCGGACT ACTTACTCTA GCTTCCCGC RACATTAAT AGACTGATG GAGCGGATA AAGTTGACG ACCACTTCTG CGCTCGGCTC
 TTGTATAAT GACGGCTTGA TGAATGAGAT CGAAGGCGG TTGTATTA TCTGACCTAC CTCGCCCTAT TTCAACGTCC TGGTGAAGAC CGGAGCGCGG
 3801 TTCCGGCTGG CTGGTTTNTT GCTGATAAT CTGGAGCGCG TGAGCGTGG TCTCGCGTA TCATGTCAG ACTGGGCGCA GATGTAAGC CTTCGGTAT
 RAGGCGACC GACCAATAA CGACTATTTA GACCTCGCGC ACTCGCACCG AGAGCGCAT AGTAACGTG TGACCCCGGT CTACCATTCG GGAGGCGATA
 3901 CGTAGTTATC TACACAGCG GGAGTCAGG AACTATGGAT GAACGAATA GACAGATCGG TGAGATAGGT GCCTCACTGA TTAAGCATTG GTAACTCTCA
 GCATCAATAG ATGTGCTGOC COTCACTGOC TTGATACCTA CTGCTTAT CTCTCTAGG ACCTATACCA CGGAGTGAAT AATTCGTAA CATTGACAGT
 4001 GACCAAGTTT ACTCATAT ACTTTAGAT GAATTAAC GAATTTTGA ATTTAAAG ATCTAGTGA AGATCTTTT TGAATACTC TGAATACTC
 CTGGTTCAAA TGAGTATATA TGAATCTTA CTAAATTTG AATTAATTTG TAAATTTTC TAGTCTACT TCTAGGAAAA ACTATTAGG TACTGCTTTT
 4101 TCCCTTAAG TGAGTTTTCG TTCCACTGAG CGTCAGACCG CGTATGCTGG GCATCTTTTC TAGTTTCTA GAGACTCT AGNAAAAA GACCGGCAT TCTGCTCTT
 AGGGAATTGC ACTCAAAAGC AAGTGACTC GCATCTGCG CCAACAAAC GGCCTAGTTC TCGATGTTG AGAAAAAGG TTCCATTTGAC CGAAGTCTAT
 4201 GCARACAAA AACCACCGC TACCAGCGGT GGTGCTTTG CCGGATCAG AGCTACAC TCCTTTTTCG AAGTACTG GCTTCAGCAG AGCCAGATA
 CGTTTGT TTTGTTGGG ATGTTGCGCA CCAACAAAC GGCCTAGTTC TCGATGTTG AGAAAAAGG TTCCATTTGAC CGAAGTCTAT
 4301 CCAATATCTG TCCCTTCTAG GTAGCGTAG TTAGCCACC ACTTCAAGAA CTCTGAGCA CCGCTACT ACTCTGCTCT GCTATCTCTG TTACAGTGG
 GGTATTGAC AGGAAGATCA CATCGGCATC AATCGGTG TGAAGTCTT GAGACATCGT GCGGATGTA TGGAGCGAGA CGATTAGGAC AATGCTCAGC
 4401 CTGCTGCCAG TGGGATTAAG TCTGTCTTA CCGGTTGGA CTCAGACGA TAGTTACCGG ATAGCGGCA GCGGTGCGG TGAACGGGG GTTCTGTGAC
 GACGACGCTC ACCGCTATTC AGCAGAAAT GCGCAACCT GAGTTCTGCT ATCAATGGCC TATTCGGGT CGCCAGCGG ACTTGCCTCTT CCGCTCTCTC
 4501 ACAGCCGAGC TTGGAGCGNA CGACTACAC CGAATGAGC TACCTACAG GTGAGCATTG AGAAGCGCC CGCTTCTCCG AAGGGAGAAA GGUGGACAGG
 TGTGCGGTG AACCTCGCTT GCTGGATG GCTTACTCT ATGGATGCG CACTCTAAC TCTTTCGCG TCGGAAGGGC TTCCCTCTCTT CCGCTCTCTC
 4601 TATCGGTAA GCGGAGGGT CGGACAGGA GAGCGACGA GAGGCTTCC AGGCGGAAAC GCTTGTATC TTTATAGTCC TGTGCGGT TCTGCTCTCT
 ATAGGCCATT CGCGTCCCA GCTTGTCT CTGCGGTGCT CCGTCAAGG TCCCTCTCTT GCGACCATAG AATATCAGG ACAGCCCAA GCGGTGAGAA
 4701 GACTTGAAGC TCGATTTTTC TGATCTCTG TCGGCGCGG GAGCTATG AAAAAAGCA GCAACCGCGC CTTTTCAGG TTCTCTCTCT TTTCTCTCT
 CTGAACCTCC AGCTAAAAAC ACTAGGCA GTCCCGCGC CTGCTATC CCGTATCT GTGGATAACC GTATTACCG CTGTGATACG CTGCGCTCAG CCAATCTAT
 4801 TTTTCTCTAC ATGTTCTTTC CTGCTTATC CCGTATCT GTGGATAACC GTATTACCG CTGTGATACG CTGCGCTCAG CCAATCTAT
 AAAACGAGT TACAGAAAAG GAGGATAG CACCTATTGG CATATGGG GAACTCAT CTGATATGCG GAGCGCTCT GAGTCTCTCT
 4901 GAGCGCAGC AGTCAGTAG CGAGGAGCG GAAGGCGCG ACCGCTCTC CCGCGCGGT TTAATCTCAGC TGAACAAATA

Figure 3-3

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CTCGCGTCGC TCAGTCACTC GCTCCTTCGC CTTCTCGCGG GTTATGCCGT TGGCGGAGAG GGGCGCGCAA CCGGCTAAGT AATTAGGTGG ACCGTGCTC
5001 GGTTCGCCGA CTGGAAGCG GGCAGTGAGC GCAACGCAAT TAATGTGAGT TACCTCACTC ATTAGGCACC CCAGGCTTTA CACTTTATGC TTCTGGGTTC
CCAAAGGCT GACCTTTCGC CCGTCACTCG CGTTGCCGTTA ATTACACTCA ATGGAGTGAG TAATCCGTGG GGTCCGAAAT GTGAATATCG AACGCCGAG
5101 TATGTTGTGT GGAATTCTGA GCGGATTAACA ATTTACACA GGAACAGCT ATGACCATGA TTACGAATTA A
ATACAAACACA CCTTAACT CGCTATTGT TAAAGTGTGT CTTTGTGGA TACTGGTACT AATGCTTAAT T
>length: 5171
```

Figure 3-4

Figure 4
PSV.IPD
length: 5712 (circular)

1 TTCCAGCTCG CCCGACATG ATTATTGACT AGAGTCGATC GACAGCTGTG CAGTTAGGCT GTGGAAAGTC CCGAGCTCC CCACGAGCA
 AAGCTCGAGC GGGCTGTAAC TAATAACTGA TCTCAGTAG CTGTGACAC GATACACACA GTCAATCCCA CACCTTCAG GGTCCGAGG GGTGCTCGT

101 GAAGATGCA AAGCATGCAT CTCATTAGT CAGCAACAG GTGTGGAAG TCCCAGGCT CCCCAGCAG CAGAACTATG CAAAGCATGC ATCTCAATT
 CTTCATAGT TTGCTACGTA GAGTTAATCA GTGTTGTC CACACCTTC AGGGTCCGA GGGGTGCTCC GTCTTCATAC GTTTCGTACG TAGAGTTAA

201 GTCAGCAACC ATAGTCCGC CCCTAATCC GCCATCCCG CCCCTAATC GCCCAGTTC CGCCATTCT CGCCCCCATG GCTGACTAAT TTTTTCATT
 CAGTCGTTG TATCAGGGCG GGGATTGAG GGGTAGGG GGGATTGAG GCGGTCAAG GCGGGTAAGA GCGGGGTAC CGACTGATTA AAAAAATAA

301 TATGACAGG CCGAGGCGC CTCGGCTCT GAGCTATTC AGAGTAGT AGGAGCTTT TTGGAGGC TAGGCTTTG CAAAAGCTA GCTTATCCG
 ATAGCTCC GGTCCGCG GAGCCGAGA CTCGATAGG TCTTCATCAC TCCTCCGAA AACCTCCG ATCCGAARAC GTTTTCGAT CGAATAGGC

401 CCGGACAGG TGCATTGGA CCGGATTC CCGTCOCAG AGTACGTA TAGACGACT AGTCCACCAT GACCGAGTAC AAGCCACAG
 GGGCTTGC ACCTAATCTT GGGCTAAG GGCAGGTTT TCACTGCATT CATGGCGAT ATCTGCTGA TCAGGTGTA CTGGCTCATG TTCCGCTGTC

501 TCGGCTCGC CACCGCGAC GAGTCGCG GGGCTCGC CCGGCTAG CACCTCCG CCGGCTTCG CCGACTACCC CGCCACGCG CACACGTA GACCTGAGC
 ACGCGAGCG GTGGGCTG CTGCGGCG CCGGCTAG GTGGAGGG CCGGCAAG GGTGATGG GCGGTCCG GTGTGCTG GTGTGCTG

601 CCACATGAG CCGGTACCG AGCTGCAAGA ACTCTTCTC ACGGCTTC GGTTCGAT CCGCAAGTG TGGTCCGG ACGCTGCT CCGCTGCTG
 GGTGTAGCT GCGCAGTGC TCAGCTTCT TGAGAAGAG TGCGCGAG CCGAGCTGA GCGTTCAC ACCCAGCG TGTGCGCG GCGCTGCTG

701 GTCTGACCA CGCGGAGAG CFTGAGAG GGGGCGGTG TCAGCGAGT CCGCGGAG ATGGCGGAT TGAGCGGTC CCGGCTGCG GCGCTGCTG
 CAGACTGCT GCGGCTCTC GCAGCTTCG CCGGCTAG CCGGCTCTA CCGGCGCG TACCGGCTA ACTGCCAG GCGCGAGCG GCGGCTGCTG

801 AGATGGAAG CTCCTGCG CCGCAGCG CCAAGAGCG CCGGTGCTG CCGGCTGCTG CCGGCTGCTG CCGGCTGCTG CCGGCTGCTG CCGGCTGCTG
 TCTACCTTC GAGGACCG GCGGTGCG GGTCTCTG CCGCAGCG GCGGCTGCG GCGGCTGCG GCGGCTGCG GCGGCTGCG GCGGCTGCTG

901 CCGGCTGCTG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCTG
 CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCTG

1001 GCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCTG
 CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCG CCGGCTGCTG

1101 TCGTCCCGT GTCCCAAT ATGGGATG GCAAGAACG AGRCTTACC TCGGATGG ACGGAGGG AGTCTTGG CAGGTTATG AAGGTTCTT ACTGTTGTTG
 ACGAGCGCA CAGGTTTAT TACCCCTAAC CGTCTTGC TCGGATGG ACGGAGGG AGTCTTGG CAGGTTATG AAGGTTCTT ACTGTTGTTG

1201 CTCCTCAGT GAAGTAAAC AGATCTGT GATATGCT GATATGCT GATATGCT GATATGCT GATATGCT GATATGCT GATATGCT
 GAGAGTAC CTCCTCAGT GATATGCT GATATGCT GATATGCT GATATGCT GATATGCT GATATGCT GATATGCT GATATGCT GATATGCT

1301 GTCTCAGT GAGAACTCA AGAACCCCA CAGGAGCTC ATTTCTTGC CAAAGTTG GATGATCCT TAAGACTAT TGAACACCG GAATTAATA
 CAGAGTCA CTCCTCAGT TCTTGTGT GCTCTCAG GCTCTCAG GCTCTCAG GCTCTCAG GCTCTCAG GCTCTCAG GCTCTCAG GCTCTCAG

1401 GTAAAGTACA CATGTTTGG ATAGTCGG GAGTTCTGT TTACAGGAA GGCATGATC CCGTAAAC CCGTAAAC CCGTAAAC CCGTAAAC
 CATTTCACT GTACCAACC TATAGCTC GGTCAAGCA ATGTCCTT CCGTAAAC CCGTAAAC CCGTAAAC CCGTAAAC CCGTAAAC

1501 GGAATTTGAA AGTGACAGT TTTTCCCGA TATGATTTG GGAATATA AACCTCTCC AGAATACCA GCGTCTCT CTUAGGTTCA GAGGAAAAA

Figure 4-1

CCTAAACCTT TCACTGTGCA ABAAGGGTCT TTAACATAAC CCCATTATAT TTGAGAGGGS TCTATGGGT CGCAGGAGA GACTCCAGGT CCHCCCTTTT
 1601 GGCATCAAGT ATAAATTTGA AGTCTAGCAG AAGAAGACT AACGTTAACT GCTCCCTCTCC TAAGGTATG CATTTTANA AGACCAATGG ACTTTTCTG
 CGGTAGTTCA TATTCAAACT TCAGATGCTC TTCTTTCTGA TTGCAATGA CGAGGGGAGG ATTCENTAC GTAAATATAT TCTGGTACCC TGAAGAGGAC
 1701 GCTTTAGATC CCCTTGGCTT CGTTAGAGG CAGTACAAAT TAATACATAA CCTTATGTAT CATACACATA CGATTAGGT GACATATAG ATAAACATCA
 CGAATCTAG GGAACCGGA GCAATCTGC GTGATGTGA ATATGTATTT GMAATACATA GTATGTATAT GCTAAATCCA CTGTATATC TATTTAGGT
 1801 CTTTGGCTTT CTCTCCACAG GTGTCCACTC CCAGTCCAA CAGTCCAGT GGTCCAGTT GACTCCAGC CAGATAGT AACTTAAGG GCCCTAGGA GATCTCAGCT GACGCTCTTC
 GAAACGAAA GAGAGGTGTC CACAGGTGAG GGTCCAGTT GACTCCAGC CAGATAGT AACTTAAGG GCCCTAGGA GATCTCAGCT GACGCTCTTC
 1901 CTTGATGGC CGCCTGGCC CAATTTGTTT ATGTCAGCTT ATATGCTTA CAAATAGC ANTAGCTCA CAATTTTAC AATAAAGCA TTTTTCATC
 GAAGCTACCG GCGGTACCG GTTGAACAAA TAAGTCCAA TATTAACAAT GTTTATTTG TATCGTAGT GTTAAAGT TTTATTTCT AAAAAGCTC
 2001 TGCATCTAG TTGTGGTTG TCCAACTCA TCAATGTATC TTAATGTGTC TGAATGTATC GGAATTAAT TCGGCGCAG ACCRTGGCTT GAAATAACCT
 ACCTAAGATC AACACCAAC AGCTTTGAGT AGTTACTAG ANTAGTACAG ACCTAGCTAG CCCTTAATTA AGCGGCTCG TGGTACCGGA CTTTATTTGA
 2101 CTGAAGAGG AACTTTGTTA GETHCTTCT GAGGCGAAA GAACCAAGCTG TGGATGTGT GTGATTTAGG GTGTGAAAG TCCCCAGGT CCCCAGCAAG
 GACTTTCTCC TTGAACCAAT CCATGGAAGA CTCGCCCTTT CTGGGTGAG ACCTTACACA CAGTCAATCC CACACCTTC AGCGGTCCGA GGGGTCTCTC
 2201 CAGAAATATG CAAGCATGC ATCTCAATTA GTCAAGCAAC AGGTGTGGA AGTCCCAAG CTCCCAAGCA GGCAGAAAT TGCNAAGCAT GCATCTCAAT
 GTCTTCATAC GTTTCGTAGC TAGAGTTAAT CAGTCGTG GGCAGCTT TCAAGGCTC TCGGGTCC GAGGGTCT CCGTCTTCAT ACGTTTCGTA CGTAGAGTTA
 2301 TAGTCAGCAA CCATAGTCC GCGCTTACT CCGCCATCC CCGCCCTAAC TCCGCCAGT TCCGCCCATT CTCGCCCA TGGCTGACTA ATTTTCTTTA
 ATCAGTCTGT GGTATCAGG CCGGATGA GCGGGTATG GCGGGATG AGGGGTGTA AGCGGGTAA GAGCGGGGT ACCGACTGAT TAAAAAAT
 2401 TTTATGAGA GCGGAGGCC CCGTGGCT CTGAGTAT CTGAGTAT CTGAGTAT TTTTGGAG CTTAGGCTTT TCCAAAAC TTTTACCTG
 AATAGCTCT CCGGCTCGG GAGAGCGGA GACTCGATA CCGTCTCAT ACTCTCCGA AAAACCTCC GATCCGAAA ACGTTTTCG ACAATGAGC
 2501 AGCGCGGCT TAAATAGGC GCGCAATTA ATCTGTGAG GTACAGCTT GGCATGCTC CCGTACCG CAGCAAAATG TTGAGCACT GACCTTTTG GAGCCCAAT
 TCGCCGCGGA ATTAATCCG CCGGTAAAT TTAGGACGTC CATCTCGAA CCGTACCG CAGCAAAATG TTGAGCACT GACCTTTTG GAGCCCAAT
 2601 CCCACTTAA TCGCTTGA GCATCCCC CCGTCCGAG CTGGCTTAA AGCAAGAGG CCGCACCGA TCGCCCTTCC CACAGTTG GTAGCTTAA
 GGGTTGAAT AGCGAAGCT CGTGTAGGG GGAAGCGTC GAGCGATTA TCGCTTCTCC GCGCTGCT AGCGGAAAG GTTGTCAAG CATCGCACTT
 2701 TGGCATGG CCGTGTAGC GATATTTCT CCGTGTAGC CTGTGCGTA TTTTACACCG CATAGTCAA AGCAACATA GTAGCGCCC TGTAGCGG
 ACGCTTACC GCGCTAGC CATTAAAGA GCAATCGTA CACAGCAT AAAGTGTGC ATAGCTGCT GCGCTGCT AGCGGAAAG GTTGTCAAG CATCGCACTT
 2801 CATTAAGGC GCGGCTGTC GTGTTAGC GCAGCTGAC CCGTACAT CCGTACAT CCGTACAT CCGTACAT CCGTACAT CCGTACAT CCGTACAT CCGTACAT
 GTATTTGG CCGCCACAC CACCAATGCG CCGTACAT CCGTACAT CCGTACAT CCGTACAT CCGTACAT CCGTACAT CCGTACAT CCGTACAT
 2901 CAGTTTCCC GCGTTTCCC GTCACTCT AAATCGGGG CTCCCTTTAG GGTTCGAT TAGTCTTTA CCGCACCTCG ACCCAAAA ACTTGTATTTG
 GTGCAAGCG CCGAAAGGG CAGTTCGAGA TTAGCCCC GAGGAAATC CCAAGCTAA ATCAGCAAT CCGCTGAGC TGGGGTTTT TGAATAAA
 3001 GGTGATGTT CACTAGTGG GCGATCGCC TGTAGAGCG TTTTTCGCC TTGAGCTTG GAGTCCAGT TCTTTATAG TGAATCTTTG TTTCAAACTG
 CCATACCAA GTGATCACC CCGTACCG CCGTACCG ACTATCTGCC AAAAGGCGG AACTGCAAT CTCAGTGA AGAATATC ACCTGAGAAC AAGTTTTCAC
 3101 GAACAACACT CAACCTATC TCGGCTTAT CTTTTCATTT ATAGGATTT TTGCGGATTT GGTAAATAAT CAGCTGATTT AAAAAAAT
 CTTGTGTGA GTTGGGATAG AGCCGATAA TATTCCTTA AACGCTAAA GCGGATTAAC CAATTTTTTA CTCGACTAAA TTTTCTTTAA
 3201 TAACCGAAT TTTAACAAA TATTAAGTT TACATTTTA TGGTCACT TCAGTACAT CTGCTCTGAT GCGCATAGT TAAGCAACT CACTATCTG
 ATTGGGCTTA AATTTGTTT ATATTTGCA ATGTTAAAT ACCACGTGAG AGTCAATGTA GACGACTA CCGCGTATCA ATTCTGTTGA GCGATAGCT

Figure 4-2

3301 TACGTGACTG GGTCAATGGCT GCGCCCGGAC ACCCGCAGC ACCCGCTGAC GCGCTGTGCT GCTCCCGGCA TCCGCTTACA GACAAGCTCT
 ATGCACTGAC CCAGTACCGA CCGCGGGCTG TGGCGGGTGG TGGCGGAGCTG CCGCGGAGCTG CCGGACAGCA CGAGGGCGGT AGCGGAATGT CTGTTCGGACA
 3401 GACCGTCTCC GGGAGCTGCA TGTGTACAG GTTTTTCACG TCATCACCGA AAGCGGCGAG GCAGTATTCT TGAAGACGAA AGGGCTCTCT CATACGCCCTA
 CTGGCAGAG CCGTCGACGT ACACAGTCTC CMAAGTGGC AGTAGTGGCT TTGCGGCTC CGTCATAAGA ACTTCTGCTT TCCCGGAGCA CTATGCGGAT
 3501 TTTTATPAGG TTAATGTCAT GATTAATATG GTTTCCTPAGA CGTCAGGTGG CACTTTTCGG GGAATGTGC GCGGAACCCG TATTGTGTTA TTTTCTTAAA
 AAAATATCC AATTACAGTA CTATTATTAC CAAAGATCT GCAGTCCACC GTGAAPASC CCTTTACAG CCGCTTGGGG ATAAACAANT AAAAAGATT
 3601 TACATTCAAA TATGTATCCG CTCATGAGC AATAACCTG AATAATGCTT CAATATATT GMAAAGGAA GAGTATGAGT ATTCACACTT TCCGTGTGCG
 ATGTAAGTTT ATACATAGGC GAGTACTCTG TTATTTGGGAC TTATTACGAA GTTATTATAA CTTTTCTCTT CTCATACTCA TAAAGTTGTA AGGCACAGCG
 3701 CCTTATPCC TTTTTCGG CATTTCCT TCCGTGTTTT GCTCACCCAG AAACCTGGT GAACTGTA GATGCTGTAAG ATCAGTTTGG TGCAGGAGT
 GGAATAGGG AAAAAGGCC GTAAACGGA AGCAGAAAA CAGTGGGTC TTTCGGACCA GTTTCATTTT CTAAGACTTC TAGTCAAOCC ACCTGCTCAC
 3801 GGTATCATCG AACTGATCT CAACAGCGST AAGATCTTG ACGTGTTCG CCGCERAGAA CGTTTCCAA TGTATGAC TTTTAAAGT CTGCTATGTC
 CCAATGTAGC TTGACCTAGA GTTGTGCGCA TTCTAGGAAC TCTCAAAAGC GGGGTCTCT GCAAAAGGT ACTACTCGTG AAAATTTCOA GACGATACAC
 3901 GCGCGGTATT ATCCGCTGAT GACGCGGGC AAGAGCAACT CGGTGCGCGC ATACACTATT CTCAGATGA CTGTGTTGAG TACTACCCAG TCACAGAAAA
 CGCGCCATAA TAGGGCACTA CTGGGCGCG TTCTGCTTGA GCGAGCGCGG TATGTATPAA GATGCTTACT GAACCAACTC ATGAGTGGTC AGTGTCTTTT
 4001 GCATCTTACG GATGGCATGA CAGTAAGAGA ATTATGCAST GCTGCAVAA CCATGAGTGA TAACACTGCG GCCACTTAC TTCTGACAA GATCGGAGCA
 GSTAGAAATGC CTACCGTACT GTCAATCTCT TAATAGCTCA CACCGGTATT GGTACTACT ATTGTGACCG CCGTTGAATG AAGACTGTG CTACCTCTCT
 4101 CCGAGGAGC TAACGCTTT TTTGCACAA ATGGGGGATC ATGTAACTCG CTTGATCGT TGGGAACCGG AGCTGAATGA AGCCATACA AAUACXAGU
 GECTTCTCG ATTGGGAAA AAACGTGTTG TACCCCTTAG TACATTGAGC GGAATGAGCA ACCCTGGCC TCGACTTACT TCGGTATGCT TTGCTGCTCG
 4201 GTGACACCAAC GATGCCAGCA GCAATGGCAA CAAGTTTGG CAACATATA ACTGCGCAAC TACTTACTCT AGCTTCCCGG CAACAATTA TAGACACTGAT
 CACTGTGGTG CTACGGTCTG CGTTACCGTT GTTGCAACCG GTTTCATAT TGCACCGCTG ATCAATGAGA TCGAAGGCC GTTGTAAAT ATCTGACCTA
 4301 GGAGGCGGAT AAAGTTGCGG GACCACTTCT GCGCTCGGC CTTCGCGCTG GCTGTTTTAT TGTGATATA TCTGGAGCG GTGAGCGTG GTCTGCTCT
 CCTCCGCCTA TTTCACGTC CTGGTGAAGA CCGAGCGCGG GAAGCGCGAC CGACCAATA AGCACTATT AGACTCGGC CACTCGGACC CAGAGCGCCA
 4401 ATCAATTGAG CACTGGGCC AGATGGTARG CCTCCCGTA TCGTAGTTAT CTACACGACG GCGAGTCAGG CAATATGGA TGAACGAAAT AGACAGATCG
 TAGTACGTC GTGACCCCGG TCTACCATTC GCGAGCGCAT AGCATCAATA GATGCTGTC CCTCAGTCC GTTGATACCT ACTTGTCTAGC
 4501 CTGAGATAGG TGCTTCACTG ATTAAGCATT GGTAACTGTC AGACCAAGTT TACTCATATA TACTTTAGAT TCATTTAAA CTTCATTTT AAATTAAAG
 GACTTATCC ACGGAGTGC TAATTCGTAA TCAATGACAC TCTGTTTCAA ATGAGTATAT ATCAATCTA ACTAAATTT GAGTAAAA TTAATTTTC
 4601 GATCTAGTG AAGATCTTT TTGATATCT CATGACCAA ATCCCTTAAC GTGAGTTTTT GTTCCACTGA CCGTCAGACC CCGTAAAA GATCAAGGA
 CTAGATCCAC TTCTAGGANA AACTATTAGA GTACTGTTT TAGGATTTG CACTCAAAAG CAAGTGACT CCGACTCTGG GGCATCTTTT CTAGTTTCT
 4701 TCTTCTGAG ATCCTTTTT TCTGCGGTA ATCTGCTGT TGCAGCAAAA AAACACACCG CTACAGCGG TGTGTTTTT GCGGATCAA GAGTACCAA
 AGAAGACTC TAGGAAAAA AGACGGCAT TAGACGACA ACGTTTGT TTTCGTCGCG GATGTCGCG ACCAACAAG CCGCTAGIT CTGATGTT
 4801 CTCCTTTTCC GAAGTAACT GCTTCAGCA GAGCGCAT ACCAATPACT GTCTTCTAG TGTAGCGGTA GTTAGGCGAC CACTTCAAGA ACTCTGTAC
 GAGAAAAAGG CTTCATTTGA CCGAGTCT CTGCGCTCTA TGGTTATGA CAGCAAGATC ACATCGCAT CAATCCGCTG GTGAAGTTCT TGAGACATCG
 4901 ACCGCTTACA TACCTCGTC TGTATATCT GTTACAGTG GTGCTGCCA GTGGCGATAA GTGCTGCTT ACCGTTGG ACTCAAGAG ATATTTATG
 TGGCGATCT ATGAGCGGAG ACGATTAGA CAATGCTCAC CGAGCGGCT CACCGCTATT CAGCAGAA TGGCCCAACC TGAATCTGCT TATCAATGUC
 5001 GATAAGGCGC AGCGTCCGG CTGAACGGG GGTTCGTGCA CACAGCCGAG CTTGGAGCGA ACGACTTACA CCAACTGAG ATACCTACAG CTTGAGLAT

Figure 4-3

```

C1RTTCGCG TCGCCAGCCC GACTTGCCCC CCRAGCACGT GTGTGGGCTC GAACCTCGCT TGCTGATGT GGCCTGACTC TATGGATGTC GCACTCGTAA
5101 GAGAAAGCGC CACGCTTCCC GAAGGAGAA AGGGGACAG GTATCCGGTA AGCGCAGGG TCGGAACAGG AGGAGCTTTC CAGGGGAGAA
CTCTTTGCGG GTGGGAAGGG CTTCCCTCTT TCCGCTGTC CATAGGCCAT TCGCGTCCC AGCCTTGTC TCTCGGCTGC TCCCTCGNAG GTCCCCCTTT
5201 CGCTGCTAT CTTTATAGTC CTGTGCGGTT TCGCCACCTC TCACTTACG GTGATGCTCG TCAGGGGGG GAGGCTATG GAAAAAGCCC
GCGACCATTA GATATATCAG GACAGCCCAA AGCGGTGAG ACTGACTCG CAGCTAAAA CACTAGGAGC AGTCCCCCG CCTCGGATAC CTTTTTGGG
5301 AGCAGCGCG CCTTTTACG GTTCTGSCC TTTTGTGGC CTTTGTCTCA CATGTTCTT CCTGGTTAT CCCCTGATT TGTGGATAAC CGTATTACUG
TCGTTGCGC GGAANAATGC CAAGGACCG AAGAGGACG GAAACGAGT GTACAAGAA GAGCGATAAG ACACCTATTG GCATAATGGC
5401 CCTTTGAGTG AGCTGATACC GCTGCGCCA GCGGACGAC CGAGGCGAG GATCAGTGA CCGAGGAGC GGAAGAGCG CCAATAGGCA AACGGCTCT
GGAARCTCAC TCGACTATGG CGAGCGCGT CGGCTGTCTG GCTCGGCTG CTGCTCTCG GCTTCTCGG GGTATGCGT TTGCGGAGAG
5501 CCGCGCGGT TGGCCGATC ATTAATCAG CTGGACGAC AGTTTCCCG ACTGAAAGC GGGCAGTGA CCAAGCGCA TTAATGTAG TTACCTCACT
GGGCGGCGCA ACGGCTAAG TAATTAGTC GACGCTGCTG TCCAAAGGC TGACCTTTG CCGTCACTC GCGTTCGTT RATTACACTC AATGGAGTGA
5601 CATTAGGCAC CCGAGGCTT ACCTTTATG CTTCCGGCTC GTATGTTGTC TGGAAATTG AGCGGATAAC AATTTACAC AGGAAACAGC TATGACCATG
GTAATCGTG GGTCCGAA TGTGAATAC GAGGCCGAG CATACAACAC ACCTTAACAC TCGCCTATTG TTAAAGTGTG TCCTTTGTG ATACTGGTAC
5701 ATTACGAATT AA
TAATGCTTAA TT

```

>length: 5712

Figure 4-4

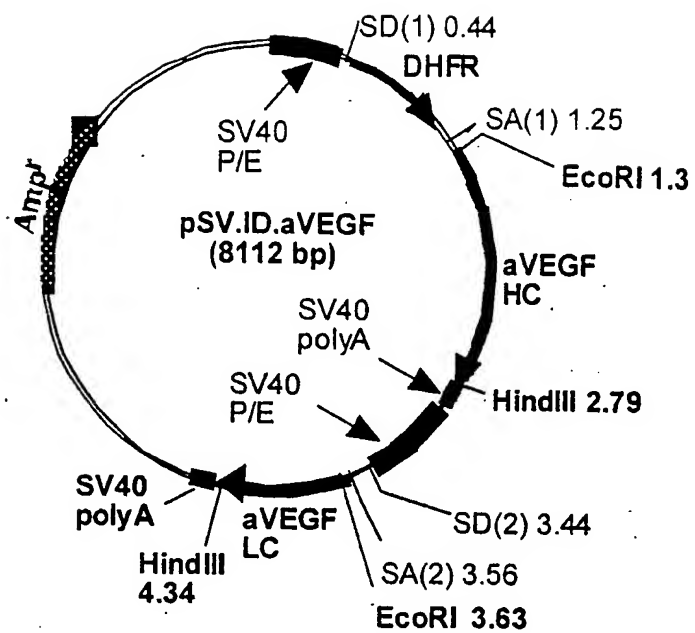


Figure 5, pSV.ID.aVEGF control plasmid

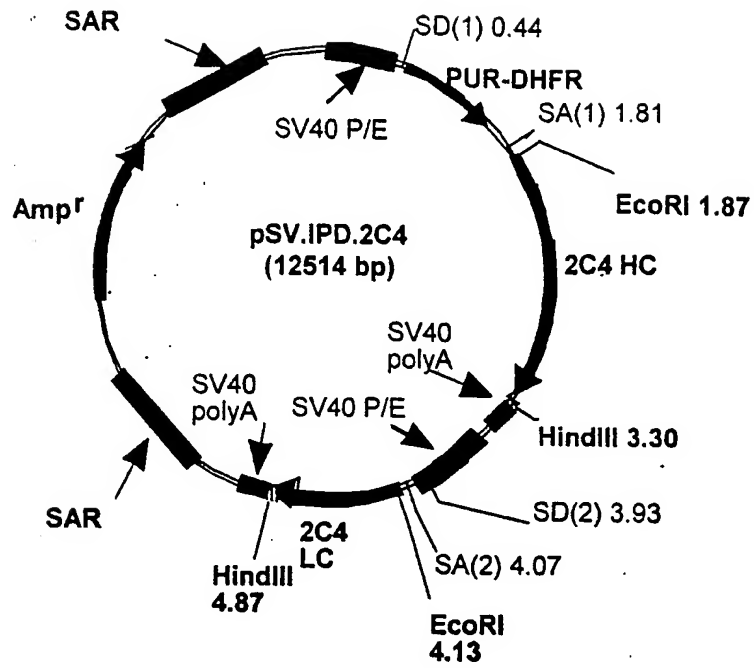


Figure 6. pSV.IPD.2C4

Figure 7
psv.IPD.2C4
 length: 12514 (circular)

1 ITGAGCTCG CCGACATTCG ATTATTCAGT AGAGTCGATC GACAGCTGTG GAATGTGTGT CAGTTAGGTT GTGGAAGTC CCGAGGCTCC CCGACGAGCA
 AGCTCGAGC GGGCTGTATC TAATACTGA TCTCAGTAG CTGTGACAC CTTACACACA GTCAATCCCA CACCTTTCAG GGGTCCGAG GTCGTCCGT
 101 GAAGTATGCA AAGCATGCAT CTCATATAGT CAGCAACAGG GTGTGGAAG TCCGAGGCT CCGCAGCAGG CAGAGTATG CAAAGCATGC ATCTCAATTA
 CTTCAATCGT TTGCTACGTA GAGTTAATCA GTGTGTCGTC CACACCTTTC AGGGTCCGA GGGGTGCTCC GTCTTCATAC GTTTCGTACG TAGAGTTAAT
 201 GTGAGCAAC ATAGTCCCGC CCGTAATCC CCGTAATCC CCGTAATCC CCGTAATCC CCGTAATCC CCGTAATCC CCGTAATCC CCGTAATCC
 CAGTCTTGG TATCAGGGG GGGATTGAG GGGATTGAG GGGATTGAG GGGATTGAG GGGATTGAG GGGATTGAG GGGATTGAG GGGATTGAG
 301 TATGCAAGG CCGAGGCGC CTGCGCTCT GAGTATTC AGAGTAGTG AGAGGCTTT TTTGGAGGCC TAGGCTTTTG CAAAAGCTA GCTTATCCGG
 ATACGTCTCC GGTCCGGCG GAGCCGAGA CTCGATPAGG TCTTCATCAC TCTCCGAA AAGCTCCGG ATCCGAAAC GTTTTCGAT CCAATAGGCC
 401 CCGGNAAGG TGCATTGGA CCGGATTCC CCGTCCAG AGTACGTAA GTACCGCTA TAGACGACT AGTCCACCAT CACCGATAC AAGCCACGG
 GCGCTTGGC AGTAACCTT GCGCCTAAG GGCACGTTT TCACTGCTT CATGCGGAT ATCTGCTGA TCAGTGCTA CTGGCTCATG TTCGGTTCU
 501 TGGCCTCGC CACCGCGAC GAGTCCCGC GGGCGGTAG CACCTTCGC GCGCGTTCG CCGACTACCC CCGCAGCGC CACACCTGAG ACCCGAGCCS
 ACGCGAGCG GTGGCGCTG CTGCAAGGCG CCGGCGATC GTGGAGCG GCGTATGG GCGTATGG GCGTATGG GCGTATGG GCGTATGG
 601 CCACATCAG CCGTCAACG AGTCAAGA ACTCTTCCT ACCTGCTG GCGTACAT CCGCAGGTTG TGGTCCCG ACCAGCGCG CCGGTGGU
 GGTAGCTC GCCAGTGGC TCGAGTTCT TGAGAGGAG TCGCGCGAG CCGAGCTGA GCGTTCCAC ACCAGCGCC TCGTCCCGC GCGCACCCG
 701 GTCTGGACCA CCGCGGAG CGTGAAAG GGGCGGTGT TCGCCGAGT CCGCCGCGC ATGGCGGAGT TGGCGGTTG CCGGTGCGC CCGCAGCAAC
 CAGACCTGT GCGGCTCTC GCAGTTCCG CCGCAGGCG CCGCAGGCG CCGCAGGCG CCGCAGGCG CCGCAGGCG CCGCAGGCG CCGCAGGCG
 801 AGATGAAG CTTCTGSCG CCGCAGGCG CCGCAGGCG CCGCAGGCG CCGCAGGCG CCGCAGGCG CCGCAGGCG CCGCAGGCG CCGCAGGCG
 TCTACCTTC GAGGACCGC GCGTGGCG GGTCTCGG GCGCAGGCG GCGCAGGCG GCGCAGGCG GCGCAGGCG GCGCAGGCG GCGCAGGCG
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 CCGCAGGCG AGTGGGCTC GAGCTCAG GGTCTCAG GGTCTCAG GGTCTCAG GGTCTCAG GGTCTCAG GGTCTCAG GGTCTCAG GGTCTCAG
 1101 TGTGCGCT GTCCCAAT ATGGGATG GCAAGAGG AGACCTACC TGCCTCGC TCAGGAGCG GTTCAAGTAC TTCNAAGTA TGACCAAAU
 AGCAGCGCA CAGGTTTTA TACCCCTAAC CTTCTCTGC CCGCTGCG CCGCTGCG CCGCTGCG CCGCTGCG CCGCTGCG CCGCTGCG CCGCTGCG
 1201 CTCTTCAGT GAAGTAAC AGAATCTGT GATATGGT AGAATCTGT AGAATCTGT AGAATCTGT AGAATCTGT AGAATCTGT AGAATCTGT AGAATCTGT
 GAGAATCAC CTTCAATTG TCTTAGACA CTAATACCA TCTTTTGA CCAAGAGTA AGGACTTTC TTAGCTGAA ATTTCTCTC TTAATTATAT
 1301 GTTCTCAGT GAGACTCA AGAACCCCA CAGAGAGCTC ATTTCTTGC CAAAGTTTG GATGATCTT TAGACTTAT TGACAAACCG GAATTTGGCA
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 CATTTCATCT GTACCAACOC TATAGCTTC CCGTCTCTT CCGTCTCTT CCGTCTCTT CCGTCTCTT CCGTCTCTT CCGTCTCTT CCGTCTCTT CCGTCTCTT
 1501 GGAATTTGAA AGTGACACGT TTTTCCAGA ATTGATTTG GGAATATATA AACCTCTCC AGAATACCA GCGCTCTCT CTGAGGTTCA GAGGAAAAA

Figure 7-1

CCTTAAACTT TCACTGTGCA AAAAGGCTCT TTAACATAAC CCCTTTATAT TTGGAGAGGG TCTTATGGGT CCGCAGGACA GACTCCAGGT CCTCCTTTT¹
 1601 GGCATCAAGT ATAACTTTGA AGTCTAGGAG AAGAAAGACT AAGCTTAACT GCTCCCTCC TAAAGCTATG CATTTTATA AGACCATGGG ACTTTTCTG
 CCGTAGTTCA TATTCAAACT TCAGATGCTC TTCTTTCTGA *End DHER TTGCAATGA CGAGGGGAGG ATTTCGATAC GTAAATAAT TCTGGTACCC TGAATAACGAC
 1701 GCTTTAGATC CCGTTGGCTT CGTTAGAACG CAGCTCAAAAT TAATACATAA CCTTATGAT CATACACATA CGATTTAGCT GACACTATAG AATAACATCC
 CGAATCTAG GGAACCGGA GCAATCTTGC GTGATGTTA ATTATGTATT GGAATACATA GTATGTGTAT GCTAATCCA CTGTGATATC TTATTGTAGG
 1801 ACTTTGCCCT TCTCTCCACA GGTGTCCACT CCAGGTCCA ACTGCACCTC GGTCTCTACG ATTCAATTC ACCATGGGAT GGTATGTAT CATCCTTTT¹
 TGAACCGGA AGAGAGGTGT CCACAGGTGA GGTCCAGGT TGAAGTGGAG CCAAGATPAG TAACCTAAGG TGGTACCCTA CCACTACATA GTAGGAAAAA
 1901 CTAGTAGCAA CTGCACTGG AGTACATCA GAAGTTCAGC TGGTGGATC TGGCGGTGGC CTGGTGCAGC CAGGGGGGTC ACTCGGTTTG TCTGTGSCAG
 GATCATCGTT GACGTTGACC TCATGTAACT CTTCAAGTGC ACCACTCAG ACCGCCACCG GACCAAGTCG GTCCCCCGAG TGAGGCAAAAC AGGACACCTC
 2001 CTTCTGGCTT CACCTTCACC GACTATACCA TGGACTGGGT CCGTCAAGGC CCGGTAAAGG GCTTGAATG GGTTCGAGAT GTTAATCCTA ACAGTGGCGG
 GAAGACCGAA GTGGAGTGG CTGATATGTT AACTGACCA GGCAGTCCG GGCACCTTAC CCAACGTCTA CNAITAGAT TGTACCCGCC
 2101 CTCATCTAT AACACGGCT TCAAGGGCGG TTTCACTCTG AGTGTGACA GATCTAATAA CATATTATAC CTGCAGATGA ACAGCCTGGG TGCTGAGGAC
 GAGATAGATA TTGCTCGCA AGTTCCCGC AAGTGGAG TCACAACTGT CTAGATTTT GTCTAATATG GAGTCTACT TGTGGAGCG ACGACTCTCTG
 2201 ACTGCCGTCT ATTATTGTGC TGTAACTCTG GACCTCTCT TCTACTTTGA CTACTGGGT CAAAGAACCC TGGTCACCGT CTCTCCGCC TCCACCAAGG
 TGACGGCAGA TAATAACAG AGCATTTGGAC CCTGGGAGAA AGATGAACT GATGACCCCA GTTCTTGGG ACCAGTGGCA GAGGAGCGG AGGTGGTTCC
 2301 GCCATCGGT CTTCCTCTG GACCTCTCT CCAAGAGCAC CTCTGGGGC ACAGCGGCC TGGGCTGCC TACTTCCCG TACTTCCCG AACCGGTGAC
 CGGTGAGCA GAAGGGGAGC GTGGGAGCA GTTCTCTGTC GAGACCCCGG TGTGCGCGG ACCGACGGA CCAAGTTCCTG ATGAAGGGG TTTGGCCACTG
 2401 GGTGTCTGG AACTCAGCG CCGTACCGAG GGCCTGAC ACCTTCCCG CTCTCTACA GTCTCAGGA CTCTACTCCC TACAGACCGT GGTGACTGTG
 CCACAGCAC TTGAGTCCG GGTCTGTC GCGCACGTC TGAAGGGCC GACAGATGT CAGGAGTCTT GAGTGAAGG AGTCTGCGCA CCACTGACAC
 2501 CCTCTAGCA GCTTGGGCAC CCAGACCTAC ATCTGCAAG TGAATCACAA CCCCAGCAAC ACCNAGGTGG ACNAGAAAGT TGAGCCCAA TCTTGTGACA
 GGGAGATCGT CGAACCCGTG GGTCTGGATG TAGAGTTGCT ACTTATGTTT GGGGTCTGTT TGGTTCACC TGTTCTTCA ACTCGGGTTT AGAACACTGT
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 TTTGAGTGT TACGGGTGGC ACGGTCTG GACTTGAGA CCCCCTGSC AGTCAGAGG AAGGGGGG TTTTGGGTTT CTCTGGGAGT ACTAGAGGGC
 2701 GACCCCTGAG GTCACATGCG TGGTGGTGA GGTGAGCCAC GAAGACCCCTG AGGTCAAGTT CAACTGGTAC GTGGACGGCG TGGAGGTGCA TAATGCCAAG
 CTGGGACTC CAGTGTAGC ACCACCACT GCACTCGTG CTCTGGGAC TCCAGTTCAA GTTGACCATG CACCTCCCG CACTCCACGT ATTACGGTTC
 2801 ARAAGCCG GGGAGGAGCA GTACAACAG ACCTACCGG TGGTCAAGGT CCACTCCGTC CTGACCCAG ACTGGCTGAA TGGCAGGAG TACAAGTGA
 TGTTCGGG CCGTCTCTG CATGTTGTG TGCATGGCC ACCAGTCCCA GGAGTGGCAG GACGTGGTCC TGACGACTT ACCGTCTCTC ATGTTACCGT
 2901 AGGTCTCCAA CAAAGCCCTC CAGCCGCCA TCGAGAAAC CATCTCCAAA GCCAAAGGC AGCCCGGAGA ACCACAGGTG TACACCTCG CCGCATCCCG
 TCCAGAGTT GTTTCGGAG GGTCCGGGT AGCTCTTTG GTAGAGTTT CCGTTTCCG TCGGGGCTCT TGGTGTCCAC ATGTGGAGG GGGGTAGGGC
 3001 GGAAGAGATG ACCAAGAAC AGGTGAGCT GACTGCTG GTCAAGGCT TCTATCCAG CGACATCCGC GTGAGTGGG AGAGCAATGG GCAGCCGGAG
 CCTCTCTAC TGGTCTTGG TCCAGTCGA CTGACGGAC CAGTTTCGA AGATAGGTC GCTGTAGCG CACTCAGCC TCTCGTTACC COTCGGCCCTC
 3101 AACAACTACA AGACCAAGCC TCCCGTGTG GACTCCGAG GCTCTCTCTT CCTCTACAG AGCTCACC TGGACAAAG CAGGTGGCAG CAGGGGAAGC
 TTTGTTGATG TCTGGTGGG AGGGCAGGAC CTGAGGCTGC CGAGGAGAA GGAGATCTG TTCAGTGGC ACCTGTCTC GTCCACCGTC GTCCCTTCC
 3201 TCTTCTCATG CTCCTGTATG CATAGGCTC TGCACACCA CTACACCGAG AAGAGCTCT CCGTGTCTCC GGTAAATGA GTGCGACGGC CCTACAGTGC
 AAGAGATG GAGGACTAC GTACTCCGAG AGTGTGGT CATGTCGCTC TTTCTCGAGA GGGACAGAG CCCATTTACT CACGCTGGCG GATCTCAAG

Figure 7-2

3301 ACCTGCAGAA GCTTCGATGG CCGCATGGC CCAACTTGTT TATTGACGT TATATGGTT ACAATAAAG CAATAGCATC ACAAAATTTCA CAAATAAAGC
 TGGACGTCTT CGAAGCTACC GCGGTACCG GGTGACAA ATRACGTGA ATATTACAA TGTATTATTC GTTATCGTAG TGTTTAAGT GTTTATTTCG
 3401 ATTTTTCCTA CTGATTTCTA GTTGTGGTTT GTCAAACTC ATCAATGAT ATCAATGAT CTGATCGGG AATTAATCG GCGAGCACC ATGCGCTGAA
 TAAAAAAGT GACGTAGAT CAACACAAA CAGTTTGAG TAGTTACATA GAATAGTACA GACCTAGCCC TTAATTAAGC CCGCTCGTGG TACCGGACIT
 3501 ATAACTCTG AAGAGCAAC TTGTTAGGT ACCTTCAG GCGAAGAA CCAGCTGAG ARTGTGTGTC AGTTAGGGTG TGGAAAGTCC CCAGGCTCCC
 TATGGAGAC TTTCTCCTTG AACAAATCCA TGGAAAGTCC CCGCTTCTT GGTGACACC TTACACACAG TCAATCCCAC ACCTTTCAGG GGTCCGAGGG
 3601 CAGCAGGCAG AGTATGCAA AGCATGCATC TCAATTAGT AGCAACAGG TGTGGAAGT CCCAGGCTC CCCAGCAGC AGAAGTATGC AAGCATGCA
 GTGTCGCTC TTCTAGCTT TCGTACGTAG AGTTAATCAG TCGTTGTGTC ACACCTTCA GGGGTCCGAG GGTGCTCGC TCTTCATAGC TTTCTGACGT
 3701 TCTCAATTAG TCAGACACCA TAGTCCCGCC CCTAACCTCC CCGATCCGG GGTAGGCG GGTATGAGG CCGGTCAAGG CCGGGGTACC GACTGATTAA
 AGAGTTAATC AGTGTGTTGT ATCAGGCGCG GGTATGAGG GGTATGAGG GGTATGAGG GGTATGAGG GGTATGAGG GGTATGAGG GGTATGAGG GGTATGAGG
 3801 TTTTATTTT ATCGAGGCG CAGGCGCGCC TCGGCTCTG AGCTATTCCA GAATGATGTA GGAGCTTTT TTGGAGGACT AGGCTTTTGC AAAAAGCTAG
 AAAAAATARA TAGTCTCCG GCTCCGCGCG AGCGGAGAC TCGATAAGGT CTTCATCACT CCTCGAAAA AACCTCCTGA TCCGAAAAAG TTTTTCGATC
 3901 CTTATCGGC CGGGAACGGT GCATGGAAC GCGATTCCC CGTCCCAAGA GTCAAGTAAAG TACGCTTAT TACGCTTAT AGAGCTTATA GCGCCACCCC CTTCGGCTTCG
 GATAGGCCG GCGCTTGCCA CGTAACTTG CGCTAAGG GCGGCTTCT CAGTCCATTC ATGCGGGAATA TCTCAGATAT CCGGTGCGG GAAACCGNAGC
 4001 TTAGAAGCG GCTACAAATTA ATACATAACC TTTTGGATCG ATCTACTGA CACTGACATC CACTTTTCT TTTTCTCCAC AGGTGCTCCAC TCCCAGGTCC
 ATCTTTGCGC CGATGTTAAT TATGTTATGG AAAAACTGAG GTGACTGTAG GTGAAAAAGA AAAAGAGGTG TCCACAGGTG AGGGTCCAGG
 4101 AACTGCACCT CGSTTCCGA AGCTAGCTG GGTGCTATCG ATTTGAATCC ACCATGGAT GGTATGAT CATCTTTT CTAGTAGCAA CTGCAACTGG
 TTGACGTGGA GCGAAGGCT TCGATCGAAC CCGAGCTAGC TAACTAAGG TGSTACCTTA CCAGTACATA GTAGAAAAA GATCATCTGT GACGTTGACC
 4201 AGTACATTTA GATATCCAGA TGACCTAGTC CTGCTAGCTC CTGCTAGCTC CTGCTAGCTC CTGCTAGCTC CTGCTAGCTC CTGCTAGCTC CTGCTAGCTC
 TCAATGTAAGT CTATAGTCT ACTGGTCTAG GGTCTGAG GGTCTGAG GGTCTGAG GGTCTGAG GGTCTGAG GGTCTGAG GGTCTGAG GGTCTGAG
 4301 ATTGGTGTG CCTGGTATCA ACAGAAACCA GGAAGCTC GGAAGCTC GGAAGCTC GGAAGCTC GGAAGCTC GGAAGCTC GGAAGCTC
 TACCCACAGC GGACCATAGT TGTCTTTGGT CTTTCTGAG GCTTTGATGA CTAAATGAGC CGAAGGATGG CTATGTGACC TCAGGGAAGA GCGAAGAGAC
 4401 GATCCGTTT TGGGACGGAT TTCACTCTGA CCATCAGCAG TCTGACGCA CAAGACTTCG CAACTTATTA CTGTCAACAA TATTATATTT ATCTTTACAC
 CTAGGCCAAG ACCCTGCTA AGTGAGACT GGTAGTCTG AGAGTCTGG CTCTGAGC GTTGAATAT GACAGTTGTT ATAATATATA TAGGAATGTG
 4501 GTTTGGACAG GGTACCAAGG TGGAGATCRA ACAGACTGTG GCTGACCAT CTGTCTTCTAT CTTCCTCGCA TCTGATGAGC AGTTGAAATC TGGAACTGCT
 CAPACCTGTC CCATGGTTCC ACCTCTAGTT TGTCTGACAC CGAGCTGTGA GACAGAGTGA GAAGGCGGT AGACTACTG TCACTTTAG ACCTTACCGA
 4601 TCTGTTGTGT GCTGCTGTA TAACTTCTAT CCGAGAGG CCAAGTACA GTGGAAGTG GATTAAGGCC TCCATCGGG TAACTCCAG ATTGAGGGTC CTCTCAGCT
 AGACAAACACA CCGACGACTT ATTAAGATA GGTCTCTCC GGTCTCTCC GGTCTCTCC GGTCTCTCC GGTCTCTCC GGTCTCTCC GGTCTCTCC GGTCTCTCC
 4701 CAGAGCAGGA CAGCAGGAC AGCACCTACA GCTCAGCAG CACCTGACG CTGAGCAAG CAGACTAGGA GAAACACAAA GTCTAGGCT GGAAGTCTAC
 GTCTGCTCT GTGCTTCTCT TGTGATGT TGTGATGT TGTGATGT TGTGATGT TGTGATGT TGTGATGT TGTGATGT TGTGATGT TGTGATGT
 4801 CCATCAGGCG CTGAGTCTG CCGTACAAA GAGCTTCAAC AGGGGAGAGT GTTAAGCTTC GATGGCGCC ATGGCCUAC TTGTTTATPG CAGCTTATAA
 GGTAGTCCCG GACTCGAGCG GCGAGTGT TCTGAGTGT TCTGAGTGT TCTGAGTGT TCTGAGTGT TCTGAGTGT TCTGAGTGT TCTGAGTGT TCTGAGTGT
 4901 TGTGTACAAA TAAAGCAATA GCATCAGAAA TTTTCAAAAT AAGCAATTTT TTTTCACTGCA TTTTCACTGCA TTTTCACTGCA TTTTCACTGCA TTTTCACTGCA
 ACCAATGTTT ATTTCTTAT CGTAGTGT TTTTCACTGCA TTTTCACTGCA TTTTCACTGCA TTTTCACTGCA TTTTCACTGCA TTTTCACTGCA TTTTCACTGCA
 5001 CATGCTGGA TCGGGAATTA ATTCGGCGCA GCACCTAGG CTGAATAAG TTTTAAACCT CTGAAGAGG AACTTGTGTA GGTACGACT AGTAGCAAG
 GTACAGACCT AGCCCTAAT TAAGCGCGCT GGTGTTTCC GACTTTATTC AATTTTGGGA GACTTTTCTCC TTTGACCAAT CCATGGCTGA TCATCGTCC

Figure 7-3

5101 TCGCCACGCA CAGATCAAT ATTRACATC AGTCATCTCT CTTTACCAAT AAAAGGTGA. AAATATACAT TTTAAAATG ACACCATAGA CGATGTATGA
 AGCGTGCGT GTTCTAGTTA TAATGTGTAG TCAGTAGAGA GAATCGTTA TTTTCCACT TTTAATGA AAATTTTAC TGTGTTATCT GCTACATCT
 5201 AAATATCTTA CTGTGAATA ATCTAGGCA AAGAAGTGA AGACTGTAC CCAGAAACT TACAAATGT AAATGAGG TTAGTGAAGA TTTAATGAA
 TTTATTAGAT GAACCTTTAT TTAGTCCGT TTTTCACTG TCTGACAATG GGTCTTTGA ATGCTTTGA TTTACTCTCC AATCCTCTCT AAATTTACTT
 5301 TGAAGATCTA AATAAATTA TAAATGTGA GAGAAATTA TGAATGTCTA AGTATGTGA GAAACGAGA GACATCTAT ATTATCATG TAAAGACTT
 ACTTCTAGAT TTAATTTGAAT ATTTAACACT CTCCTTAAT ACTTACAGAT TCAATTTACGT CTTTGCTCTCT CTTGATGATA TAAATCTCTG ATTTTCTGAA
 5401 AATATTTGGA AGGTATCTT TCTTTTCA TAAATTTGA GTCAATATGT TCACCCCAA AAAGCTGTTT GTTAACTTGT CAACCTCAT TCAAAATGTA
 TTATAACACT TCCATATGAA AGAAAGTGT ATTTAACAT CAGTTATACA AGTGGGTTT TTTGACAAA CAATGAAACA GTTTGAGTAA AGTTTATCAT
 5501 TATAGAAAGC CCAAAGACAA TAACAAAAAT ATCTTTGTAG AACAAATGG GAAAGATGT TCCACTAAAT ATCAAGATTT AGAGCAAGC ATGAGATG
 ATATCTTTTC GGTCTCTCTT ATGTTTTTA TAAGAACATC TTGTTTTTACC CTTTCTTACA AGGTGATTTA TGTCTTAAA TCTCGTTTCG TACTCTACAC
 5601 TGGGGATAGA CAGTGAGGCT GATAAATAG AGTAGAGCTC AGAACAGAC CAATGTATAT ATGTAGTGA COTATGAAA AAATATGGCA TTTTACAATG
 ACCCTATCT GTCACTCGA CTATTTTATC TCATCTCGAG TCTTTGTCG GCTAACTATA TACATTCAC TGTACTTTT TTTATACCGT AAATGTTTAC
 5701 GGAATATGAT GATCTTTTC TTTTGTGAA AAACAGGAA ATATATTTAT ATGTAAAAA TAAAGGGAA CCCATATGTC ATACCATACA CACAAAAAAA
 CTTTACTA CTAGAAAAAG AAAAATCTT TTTGTCCTT TATATAATA TACATTTT ATTTTCCCTT GGTATACAG TATGGTATGT GTGTTTTTTT
 5801 TTTCACTGAA TTTAATGCT AAATGGAGAA GGCAAACTT TAAATCTTTT AGAAATAT ATAGAGCAT GCATCATGA CTTCACTGTA GAGAAAAAT
 AAGTCACTT AATATTCAGA TTTACCTCTT CCGTTTGA ATTTAGAAA TCTTTTATTA TATCTCTGA CCGTAGTACT GAGTCACAT CTCTTTTAA
 5901 TCTTATGACT CAAAGTCTTA ACCAAGAA AAGATTTCTT AATTAGATG CATGAATAT AAGACTTAT TTTAATTA ABAPCCAT AAGAAAACTC
 AGAATCTGA GTTTCAGAT TGTGTTTCT TTTCTACAA TTAATCTAAC GTACTTATA TTCGATTA AAATTTAAT TTTTGGTAA TTTCTTTTCAG
 6001 AGGCAATAGA ATGACAGAAA ATATTTGCAA CACCCAGTA AAGAGATTTG TAAATGAG ATTATAPAA GAAGTCTTAC BAATCAGTAA ABAATAAAC
 TCGGTTACT TACTGTCTT TATAACGTT GTGGGTCAT TTTCTTAA ATTTATAGTC TAATATTTT CTTGAGATG TTTAGTCAAT TTTTATTTG
 6101 TAGCAAAA TTTGACAGA TGAAGAGAA ACTCTAATA ATCATACAC ATGAGAACT CAATCTCAGA BAATCAGAA CTATCATTTG ATATACATA
 ATCTGTTTTT AAATCTCTCT ACTTCTCTT TGAGATTTAT TAGTAATGT TACTCTTTGA GTTAGATCT TTAGTCTCTT GATAGTAACG TATATGTGAT
 6201 AATTAGAGAA ATATTAAG GCTAAGTAC ATCTGTGCA ATATTGAG TATATACCT TGATATGATG TGATAGAAC AGTACTTTAC CCGTGGCT
 TTAATCTCT TATATTTTC CGATTCATG TAGACACCGT TATAACTACC ATATATTTGCA ACTATCTAC ACTACTCTG TCATGAAATG GGTACCCGA
 6301 TCTTCCORA ACCCTTACC CAGTATTAAT CATGACAAAT ATCTTTTAA ACCATTTACC CTATATCTPA CCAGTACTCC TCAAACTGT CAAGGTCTATC
 AGGAGGGGT TGGGAATGG GTCATATTTA GTACTGTTA TATGAAATTT TTGTAATGG GATATAGAT TGTCTATGAG AGTTTGA GATCTAGT
 6401 AAAAATAGA AAGTCTGAG GAATGTCAA AACTAAGAG AACCACAGGA GACATGAGAA TTATATGTA TGTGCAATC TGAATGAGT CCCAGAACAG
 TTTTATTTCT TTTCACTC CTTGACAGTT TTGATTTCTCC TTGGTTCTCT TTTGATGTA ACACCGTAA GATCTACTTA GGTCTCTGTC
 6501 AAAAAGACA GTAGCTAAA AACTAATGAA ATATAATAA AGTTTGAAT TTAGTTTCTT TTTAATAAGA GTAGCTTAA CACGCAAG TCAATTTCTAT
 TTTTCTTGT CATCGATTTT TTGATTTCT TATATTTAT TCAACTTGA AATCAAAA AATTTTCT CATGTAAT GTGCGTTTC AGTAAAGTA
 6601 ATTTTCTTG AACATTAAGT ACAAGTCTAT AATTAATAA TTTTAAATG TACTCTGAA CATTTCCAGA AACAGATA CAGCAGTAT CTGTCTCTGTC
 TAAAGAAC TTGTAATCA TGTTCAGATA TTAATTTTA AAAAAATC ATCAGACCTT GTAACGCT TTTGCTTCTAT GTGTCGATA GACACACAG
 6701 GCTTACTAT CCATAGCTGA TTGGTCTTAA ATCAGATACA TCAAGCTCC TCAATGTTTT TGTGTTTTCT TTTAATGAA AACTTTAT TTTAAGAGG
 CGATTTGATA GGTATCGACT AACCAGATTT TACTCTATGT AGTTGGAGG AGGTACAAA AACAAAGAA AAATTTACT TTTGATATAA AAAATTTTUC
 6801 AGTTTCAGGT TCATAGCRAA ATTAGAGGA AGGTACATTC AAGCTAGGA AGTTTCTCT TATCTCTAGT TTAGTGAG AGTTGATCAT GAATGGTCT

Figure 7-4

TCAAGATCCA AGTATCGTTT TAACTCTCCT TCCATGTAAG TTGAGTCTCT TCAAAAGGAG ATAAGGATCA AATGACTCTC TAACGTAGTA CTTACCCACA
 6901 TAAATTTTGT CAAATGCTTT TTCTGTGTCT ATCAATATGA CCATGTGAT GGCACAAAT ACCTGTTGAT GGCACAAAT ACCTGTTGAT GGCACAAAT ACCTGTTGAT
 ATTTAANACA GTTTAGGAAA AAGACACAGA TAGTTATACT GSTTACTATA AAGAGAAAT TGGACAACTA CCCTGTTTAA TGCAATTAAC TAAAGTTTG
 7001 GTTGAACCA CTTTACATAT CTGGATATAA TTCTACTTGG TTGTTGGTGA TATTTTGGTA TACATCTCTG GATCTCTTGT GCTAATATTT TGTGAAAT
 CAACTTGGTG GGAATGTATA GACCTTATTT AGATGAACCC AACCCACAT ATAAATACT ATGTAAGAAC CTAGAAAA CGATTATRAA ACAACTTTTA
 7101 GTTTGTATCT TTGTTATCA GAGATATTTG TCTGTGTTT TCTTTCTTG TAATGTCAT TTCTAGTTC GGTATTAAG TAATCTCTG CTAGTTGAAT
 CAAACATAGA AACAAGTACT CTCTATAACC AGACAACAAA AGAAGAAGAC ATTACAGTAA AGATCAAGS CCATAATTC ATTACGACOG GATCAACTTA
 7201 GATTTAGGAA GTATTCCCTC TGCTTCTGTC TTCTGAGGTA CGCGCGCGG CCCTGCTTTT ACACGTCGT GACTGGGAAA ACCCTGGGT TACCGAACTT
 CTAATCTCTT CATAGGGAG ACGAGACAG AGACTCCAT GCGCGCGGG GGCAGCAAAA TGTTGCAGCA CTGACCTTTT TGGACCCGA ATGGGTTGAA
 7301 AATCGCTTG CAGCACATCC CCTTTCCGC AGCTGGGTA ATAGCGAGA GCGCGCGC GATCGCCCTT CCAACAGTT CCGCAGCCTG AATGGCGAAT
 TTACCGAAG CTCGTGTAGG GGGAAAGCG TCGACCGCAT TATCGTTCT CCGGGGTGG CTAGCGGAA GGTGTGCAA CGCTCGGAC TTACCGCTTA
 7401 GCGGCTGAT GGGTATTTT CTCCTTAGC ATCTGTGCGG TATTTACAC CGCATAGTC AAGACACCA TGTAGCGG CCTGTAGCG CGCATTAAGC
 CCGCGACTA CGCCATATAA GAGGATGCG TAGACACGCC ATAAAGTGT GCGTATGCG TTTCTGTTGT ATCATGGCG GACATCGCC GCGTAAATCG
 7501 GCGCGGGTG TGGTGGTTAC GCGCAGGTG ACGCTACAC TTGCGAGCG CCGTACGCC GATCGCTTCT CTTCTTCCC TTCTTTCTC GCCAGTTG
 CCGCGCCAC ACCACCATG CCGCTCGCAG TGGCGATGT NACGTCGCG GATCGCGG CGAGGAAAG GAAAGAGG AAGGAAAG CCGTGAAGC
 7601 CCGGCTTCC CGTCAAGCT CTAAATCGG GGTCCCTTT AGGTTCCGA TTATGTCCT TACGGACCT CGACCCAAA AACTTGAAT TGGTGTG
 GCGCAAGG GCGATTGCA GATTTAGCC CCGAGGAAA TCCCAAGCT AATCAAGAA ATGCGGTGA GCTGGGTTT TTTGAACATA ACCACTACC
 7701 TTCAGTAGT GGGCATCGC CCGTATGAC GGTTTTTCG CTTTGTGCT TGGAGTCCAC GTTCTTTAAT AGTGGACTCT TGTTCACAA TGGAAACA
 AAGTGCATCA CCGGTAGCG GCACTATCT CCAAAAGC GGAAGTGA ACCTAGGTG CAAGAAATTA TCACTGAGA ACAAGTTTG ACCTTCTGT
 7801 CTCACCCCTA TCTCGGGTA TTCTTTGAT TTATAGGGA TTTCGCGAT TTGCGCTAT TGGTAAANA ATGAGTGTAT TTAACAAAA TTTAACGCGA
 GAGTTGGAT AGAGCCGAT AAGAACCTA ATATTTCCCT AAACGGCTA AAGCCGATA ACCAATTTT TACTCGATA ATTTGTTTT AAATTCGCT
 7901 ATTTTAACA RATATTAAG TTTACATTT TATGTTGCAC TCTCAGTACA ATCTGCTCTG ATGCGGATA GTTAAGCAG CCGGACACC CGCAACAC
 TAAATTTGT TTATATTCG AATGTTAA ATACCAGTG AGATCATGT TAGACAGAC TACCGCTAT CAATCGCT GGGCTGTG GCGTTGTG
 8001 CCGTACGCG CCTGACGG CTGTCTGT CCGGCTATC GCTTACAGC AAGCTGTAC CGTCTCGGG AGCTGCTGT GTACAGGT GTACAGGT TACACCGTCA
 GCGACTGCG GGGCTGCG GAAACAGCA GGGCGTAGG CGAATGCTG TTGACACTG GCAGAGGCC TCGACGTACA CAGTCTCAA AAGTGGCAGT
 8101 TCACCGAAC GCGGAGAGA CGAAGGGCC TCGTATACG CTTATTTTA TAGGTTAATG TCATGATAAT AATGGTTTCT TAGACGTAC GTGGACTTT
 AGTGGCTTG CCGCTCTCT GCTTCCCGG AGCATATGC GGTAAAAAT ATCCAATTAC AGTACTATA TTACCAAGA ATCTGAGTC CACCGTGA
 8201 TCGGGGAAT GTGCGGGA CCCCTATTTG TTTATTTTC TAAATACAT CAAATATGA TCCGCTCAT AGACAATAC CTTGATAAT GCTTCAATAA
 AGCCCTTTA CACGCGCTT GGGATTAAC AATATAAG ATTTATGTA GTTTATACAT AGCGAGTAC TCTGTTATG GACTATTA CGAATTTAT
 8301 TATTGAAAA GGAAGATAT GAGTATCAA CATTTCCGT TCGCCCTAT TCCCTTTTT GCGCAATTT GCTTCTCTG TTTGCTCAC CCAGAAACG
 ATACTTTT CTTCTCTATA CTCATAGTT GTAAGGCAC AGCGGATA AGGGAANA AAGCGGTAAA CCGAGGACA AAAACGAGT GGTCTTTTUS
 8401 TGGTGAAGT AAAAGATGCT GAAGATCAG TGGGTGCACG AGTGGTTAC ATCTCAACAG CGTAAAGAT CTTGAGATTT TCGCCCCCA
 ACCACTTTCA TTTTCTACGA CTTCTAGTCA ACCAGGTG TCAACCAAG TAGCTGACC TAGATTGTC GCACTCTAG GAAGCGGCT
 8501 AGACGTTTT CCAATGATGA GCATTTTAA AGTTCTGCTA TGTGGCGCG TATTATCCC TATTAGCCC GGCAGAGC AACTCGCTG CCGCATAC
 TCTTGCAAA GGTACTACT CGTGAATTT TCAAGACGAT ACACCGGCC ATAAAGGCG ATAACTGCG CCGTTCTCTG TTGAGGCCAG GCGGTATG

Figure 7-5

8601 TATTCTCAGA ATGACTTGGT TGAGTACTCA CCACTCACAG AAAAGCATCT TACGATGCG ATGACAGTAA GAGAATTATG CAGTCTCTGCC ATACCAATGA
 ATAGAGTCT TACTGARACCA ACTCATGAGT GGTCACTGTC TTTTCTGTAGA ATGCTTACCG TACTGTCAAT CTCTTAATATC GTTACACCGG TATTGGTACT
 8701 GTGATACAC TCGGGCCAACT TTACTTCTGA CACAGATCGG AGGACCGAG GAGCTAACCG CTTTTTGTGA CAACATGGGG GATCATGTAA CTCGCCCTTGA
 CACTATTGTG ACGCGGTG AATGAGACT GTTGCTAGCC TCCGTGGCTC CTGCAATGGC GAAAAACGT GTTGTACCCG CTAGTACATC GAGCGGAATC
 8801 TCGTTGGAA CCGGAGCTGA ATGAAGCCAT ACCAAGCCAT CAGGCTGACA CCACGATGCC TGTAGCAATG GCAACACGT TCGGAAACT ATTAACATGCC
 AGCAACCCCTT GCGCTGACT TACTTCGGTA TGGTTGGT CTGCACTGT GGTGCTACG ACATCGTTAC CGTTGTGCA ACGCGTTGA TAATTGACCG
 8901 GAATCTCTTA CTCTAGCTTC CCGGCAACAA TTATAGACT GATGGAGG GGTAAAGTT GCAGACGAC TTCTGGCTC GCGCTTCCG GGTGGTGGT
 CTTEATCAAT GAGATCGAAG GCGCTTGT TATATCTGA CTTACTCTCG CTTATTTCAA CGTCTGTG AGACGCGAG CCGGGAAGG CGACCGACCA
 9001 TTATGCTGA TAAATCTGA GCGGTGAGC GTGGTCTCG CGGTATCAAT GCAGACTGG GGCAGATCG TAAGCCCTCC CGTATCGTAG TTATCTACAC
 AATAACGACT ATTTAGACT CGGCACTCG CACCCAGAGC GGCATAGTAA CGTCTGACC CCGCTTACC ATTCGGAGG GCATAGCATC ATAGATGTG
 9101 GACGGGGAGT CAGGCACTA TGGATGAACG AATAGACAG ATCGCTGAGA TAGTGCTCTC ACTGATTAG CATTGSTRAC TGTGACCA AGTTTACTCA
 CTGCCCCCTCA GTCCGTGAT ACCTACTTC TTTATCTGTC TAGGACTCT ATCCAGGAG TGACTAATTC GTAACCATNG ACAGTCTGGT TCAAAATGAGT
 9201 TATATACTTT AGATTGATTT AADACTTCAT TTTTAATTTA AAGGATCTA GGTGAAGATC CTTTTTGATA ATCTCATGAC CAAAATCCCT TAACGTGAGT
 ATATATGAAA TCTAATCTAA TTTTGAAGTA AAAATTAAT TTTCTTAGT CCACCTTCTAG GAAAACTAT TAGAGTACTG GTTTTAGGGA ATTGCACTCA
 9301 TTTCTTCCA CTGAGCTCA GACCCGCTAG AAGATCAA AGATCTCT TGAGATCCT TTTTCTCGG CGTATCTCC TCGTTGCAAA CAAAAAACC
 NAAGCAAGT GACTCGAGT CTGGGCTC TTTTCTAGT TCTTAGAGA ACTTAGGAA AAAAAGAGC GCNTTAGAG ACGAAGCTT GTTTTTTTG
 9401 ACCGCTACCA GCGGTGTTT GTTTGCGGA TCAAGACTA CCACTCTTT TCCGAAGT AACTGGCTTC AGCAGAGCG AGATACCAA TACTGTCTT
 TGGCATGTT CCGCACCAA CAAAGGCT AGTTCTGAT GGTGAGAA AAGCTTCCA TTGACCGAAG TCGTCTCGG TCTATGGTT ATGACAAAGAA
 9501 CTAGTGTAG CGTAGTAGG CCACACTTC AAGACTCTG TAGCACGCG TACATCTCT GCTCTGTAA TCGTGTACC AGTGGCTGT GCGAGTGGG
 GATCATCG GCATCAATCC GGTGTGAAG TCTGTGAGC ATGTGGGG ATGTATGAG CACACAGAT AGGACATGG TCACCGACGA CGGTACCCG
 9601 ATAAATCTG TCTTACCGG TTGACTCAA GACATAGT ACAGGATAAG GCGCAGCGT CGGCTGAAC GGGGGTTCG TGCACACAG CAGCTTGA
 TATTCAGCAC AGAATGGCC ACCTGAGT CTGCTATCAA TGGCTATTC CGCTCGCA GCCGACTG CCCCCAAGC ACGTGTGCG GGTGCACTT
 9701 GCGAAGACC TACACCGAC TGAGATACCT ACAGCTGAG CTATGAGAA GCGCACGCT TCCGAAAGG AGAAGGCGG ACAGTATCC GGTAAAGCGG
 CGCTTCTG ATGTGCTTG ACTCTATGA TGTGCACTC GATCTCTT CCGGCTGGA AGGCTTCCC TCTTCCGCC TGTCCATAGG CCATTCGCCG
 9801 ACGGTGCGAA CAGGAGCG CAGGAGGAG CTTCAGGGG GAAAGGCTG GTATCTTTAT AGTCTCTGCT GGTTCGCA CCTCTGACTT GAGCGTCTGAT
 TCCAGCTT GTCTCTGCG GTCTCTGCG GAGGTGCGG CTGTGCGAC CATAGAAATA TCAGGACAGC CCAAGAGCGT GGAGACTGAA CTGCGAGCTA
 9901 TTTTGTGATG CTCGTGAGG GGGCGAGCC TATGGAATA GCGCAGCAAC GCGGCTTTT GCGCTGCTG GGTTCGCA CCTCTGACTT GAGCGTCTGAT
 AAACACTAC GAGCAGTCCC CCGCTCTG ATACCTTTT GCGCTGCTG GCGGCTGCTG GCGGCTGCTG GCGGCTGCTG GCGGCTGCTG GCGGCTGCTG
 10001 CTTTCTGCG TTATCCCTG ATCTGTGGA TAACCTAT TACGCTGCTG AGTGTGCTG TACGCTGCTG TACGCTGCTG TACGCTGCTG TACGCTGCTG
 GAAAGGAGC AATAGGGAG TAAGACACT ATTGGCTA TGGCGGAAAC TCACTGACT ATGCGGAGC GCGTGGCTT GCTGGCTGCTG GCGTGGCTGCTG
 10101 GTGAGGAGG AAGCGGAAGA GTCCGCGGCG AAGTGGCGA CCGCAGACT AATATTAAC CACTCTTTAG CACTCTTTAG CACTCTTTAG CACTCTTTAG
 CACTGCTGCTG TCTGCTGCTG CCGGCTGCTG TCTGCTGCTG TCTGCTGCTG TCTGCTGCTG TCTGCTGCTG TCTGCTGCTG TCTGCTGCTG
 10201 ACATTTTAAA AATGACACCA TAGACGATGT ATCAATATA TCTACTTGA AATPAATCTA GGCAGAGAG TCAAGACTG TTACCCAGAA AACTTACAAA
 TGTAAATTT TTACTGTGTT ATCTGTGCTA TACTTTTAT AGATGACCT TTATTTAGT CCGTTCTTC ACCTTCTGAC AATGGGCTT TTGAATGTTT
 10301 TTGTAATGA GAGTTAGT AAGATTTAA TGAATGAAGA TCTTAATTA CTTATTAAT GTGAGAGAAA TTAATGAATG TCTAAGTTAA TGCAGACG
 AACATTTACT CTCCATCAC TTCTAATTT ACTTACTCT CACTCTCTT AATTACTTAC AGATTTCAAT ACGTCTTTC

Figure 7-6

10401 GAGAGACATA CTATATTTCAT GAACATAAAG ACTTAATATT GTGAAGGTAT ACTTCTTTT CACATAAATT TGTAGTCANT ATGTTTACCC CAAAAAAGCT
 CTCTCTGTAT GATAFRAGTA CTGATTTTC TGAATTAATA CACTTCCATA TGAAGAAGAA GTGATTTAA ACATCAGTTA TACAAGTGG GTTTTTTCGA
 10501 GTTGTGTAAC TTGTCACCT CATTTCAAAA TGTATATAGA AGCCCAAG ACAATAACAA AATATTCTT STAGAACARA ATGGGAAGA ATGTTCCACT
 CAACAAATG ACAGTTGGA GTAAAGTTT ACATATATCT TTGGGTTTC TGTATTGTT TTTATAAGAA CATCTGTTT TACCCCTTCT TACAAGGTGA
 10601 AATATCAAG ATTTAGAGCA AAGCATGAGA TGTGTGGGA TAGACAGTGA GGCTGATPAA ATAGAGTGA GCTCAGAAC AGACCAATG ATATATGTAA
 TTTATAGTTC TAAATCTGT TTCTACTCT ACACACCTCT ATCTGCTACT CCGACTATT TATCTCATCT CGAGCTTTG TCTGGTAACT TATATACATT
 10701 GTGACCTATG AAAAAAATHT GGCATTTTAC ATGGGAAAA TGAATGCTTT TTCTTTTTT AGAARACAG GGAATATAT TTATATGTAA AAAAAAAG
 CACTGGATAC TTTTTTTATA CCGTAAATG TTACCCCTTT ACTACTAGA AAGAAGAAA TCTTTTGTG CTTTATATA AATATACATT TTTTATTTTC
 10801 GGAAGCCATA TGTCTACCA TACACACAAA AATATTCCAG TGAATTATA GTCTAAATGG AGAAGGCAAA ACTTAAATC TTTTAAAAA TAATATAGAA
 CTTGGGTAT ACAGTATGGT ATGTGCTTTT TTTTAGGTC ACTAATATT CAGATTACC TCTTCCGTTT TGAATTTAG AAAATCTTTT ATATATCTTT
 10901 GCATGCCATC ATGACTTCAG TGTAGAGAA AATTTCTTAT GACTCAAGT CTTAACCAACA AAGAARAGT TGTAAATTAG ATTGCATGAA TATTAGACT
 CGTACGGTAG TACTGAAGTC ACATCTCTT TTAAGAATA CTGAGTTTCA GGATTGGTGT TCTTTTCTA ACATTAATC TARCCTACT ATAAATCTGA
 11001 TATTTTAAA ATTAARAAAC CATTAAGAA AGTCAGGCCA TAGATGACA GAAATATTT GCAACACCCC AGTAAAGAGA ATTGTAATAT GCAGATATATA
 ATAAAAATTT TAAATTTTGT GTAAATCTTT TCAGTCCGGT ATCTTACTGT CTTTATATA CGTTGGGGG TCAATCTCT TARCATTATA COTCTAATAT
 11101 AAGAGAGTC TTACAATCA GTAAAAATA AACTAGACA AATTTTGA CAGATGAAG AGAATCTA AATATCATTT ACACATGAGA AACTCAATCT
 TTTTCTCAG AATGTTTGT CATTTTTTAT TTTGTTCTGT TTTTAACTT GTCTACTTTC TCTTTGAGT TTAATAGTAA TGTGTACTCT TTGAGTTAGA
 11201 CAGAAATCAG AAGACTATCA TTGCATATAC ACTAATTTAG AGAATATTA AAGGCTTAAG TAAATCTGT GGCATATG ATGGTATATA ACCTTGATAT
 GTCTTTAGTC TCTTGATAGT AAGTATATG TGAATTAAT TCTTATAAT TTCCGATTC ATTGTAGACA CCGTATATAAC TACCATAAT TGAAGTATATA
 11301 GATGTATGA GAACGTACT TTACCCCATG GGCTTCTCC CCAACCCCTT ACCCCAGTAT AATCATGAC AATATATCTT TAAACACCAT TACCCTATAT
 CTACACTACT CTGTCTAIGA ATGGGGTAC CCGAAGGAG GTTTGGGAA TGGGTCTATA TTTAGTACTG TTTATATGAA ATTTTGGTA ATGGGATATA
 11401 CTACACAGTA CTCTCAAAA CTGTCAAGT CATCAAAAT AAGAAAGTC TGAAGGACTG TCAAACTPAA GAGGAACCA AGGACACATG AGAATATAT
 GATTGTCTAT GAGGATTTT GACAGTTCCA GTAGTTTAA TTCTTTTCAG ACTCCTTGAC AGTTTGTATT CTCTCTGGGT TCTCTGTAC TCTTATATA
 11501 GTATGTGGC ATTTGATG AGATCCAGA ACAGAAAGG ACAGTAGCT ABAARACTAA TGAATATAA ATAAAGTTTG AACTTTAGTT TTTTAAAT
 CATTACACG TAAGACTTAC TCTAGGCTCT TGTCTTTTC TTGTATCGA TTTTGTGAT ACITTAAT TATTTCAAAC TTGAATCAA AAAAATTTT
 11601 AAGATAGCA TTAACACGCG AAGTCATTT TCATATTTT CTGTACATTT AAGTACAGT CTATAATTA AATTTTITA AATGTAGTCT GGAACATTCG
 TTCTCATCT AATGTGCGG TTTCAGTAA AGTATAAAA GAATTTGTA TTCTATGTTCA GATATTAAT TTTAAAAAT TTACATCAGA COTGTAAACG
 11701 CAGAACACA AGTACAGCAG CTATCTGTG TGTGCGCTTA CTATCCATAG CTGTTGGTC TAAATGAGA TACATCAACG CTCCTCCATG TTTTGTGTTT
 GTCTTTGCT TCTGTCTGTC GATGACAGC ACAGCGGAT GATAGTATC GACTAACAG ATTTTACTCT ATGATGTTG GAGGAGTAC AAAAAACAA
 11801 TCTTTTAAA TGAATAACTT TATTTTAAA GAGGATTTT AGTTCCATAG CAATTTGAG AGAAGTAC TCCCTTCCATG TCCCTTCCAA GGAGATAAGG
 AGAAAAATTT ACTTTTGA AAAAAAAT CTCTCAAG TCCARATATC GTTTTAACT GTTTTCTGT GTCATCAAT ATGACCATG GATTTCCTC TTAACCTCT
 11901 TAGTTTACTG AGAATTTGCA TCAATGATGG GTGTTAAAT TTGTCATATG CTTTTCCTGT GTCATCAAT ATGACCATG TACTGTTTCTC TTAACCTCT
 ATCAATATG TCTCTAAGT AGTACTTACC CACAATTTA ACAGTTTAC GAAAAAGACA CAGATAGTAA TACTGTTTACA CTAAAGAGG AATTTGGACA
 12001 TGATGGGACA AATTTAGTTA ATTTATTTT AAACGTTGAA CCACCTTTAC ATATCTGAA TAAATCTAC TTGTTCTG GAGGAGTAC AACTATATTA AACTATGTA
 ACTACCTCT TTAATGCAAT TAACTAAAG TTGCAACTT GGTGGGATG TATAGACTT ATTTAGATG AACCAACAC ACATATATAA AACTATGTA
 12101 CTTGGATCT TTTTGTAT ATTTGTTGA AATGTTTGT ATCTTTGTT ATGAGAGATA TTGTTCTGTT GTTTTCTTTT CTGTAATGT CATTTCTAG

Figure 7-7


```
GAACCTAAGA AAAACGATTA TAAACAACT TTTCACACCA TAGAACCAAG TACTCTCTAT AACGAGCAA CAATAGAAA GAACATTACA GTAAAGATC
12201 TTCGGTATT AAGGTAAATG TGGCCTAGTT GAATGATTTA GGAAGTATTC CCTCTGCTTC TGTCTCTGA AGCGAAGAG CGCCCAATAC GCAACCGCC
AAGGCCATAA TTCCATTACG ACGGATCAA CTTACTAAT CTTCATAAG GGAGACGAG ACAGAGACT TCGCCTTCTC GGGGTTATG CGTTTGGCGG
12301 TCTCCCGCG CGTTGGCGGA TTCATTAAATG CAGCTGGCAC GACAGGTTTC CCGACTGGAA AGCGGGCAGT GAGCGCAACG CAATTAATGT GAGTTAGCTC
AGAGGGGGCG GCAACGGCT AGTAATTAC GTCGACGTG CTGTCCAAAG GGCTGACCTT TCGCCCGTCA CTCGGTTGC GTTAATTACA CTCATCGAG
12401 ACTCATTAGG CACCCAGGC TTACACTTT ATGCTCCGG CTGTATGTT GTGAGCGAT AACATTTCA CACAGGAAC AGCTATGACA
TGAGTAATCC GTGGGTCCG AATGTGAA TACGAGGCC GACATACAA CACACCTTAA CACTCGCTA TTGTTAAGT GTGTCCTTG TCGATACTGT
12501 TCATTACGAA TTAA
ACTAATGCTT AATT
```

>length: 12514

Figure 7-8

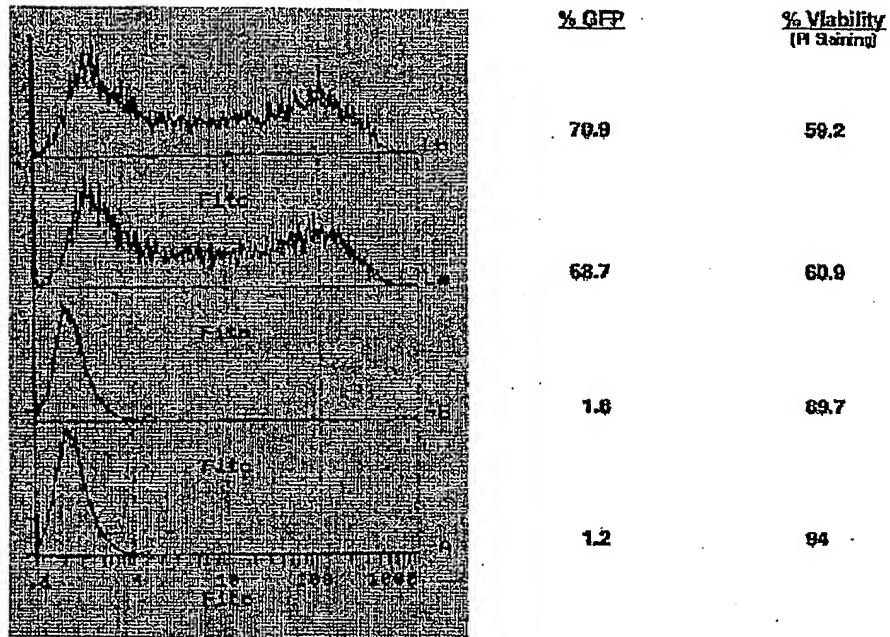


Figure 8. FACS analysis of transiently transfected CHO cells with a GFP plasmid in 250 ml spinner transfection.

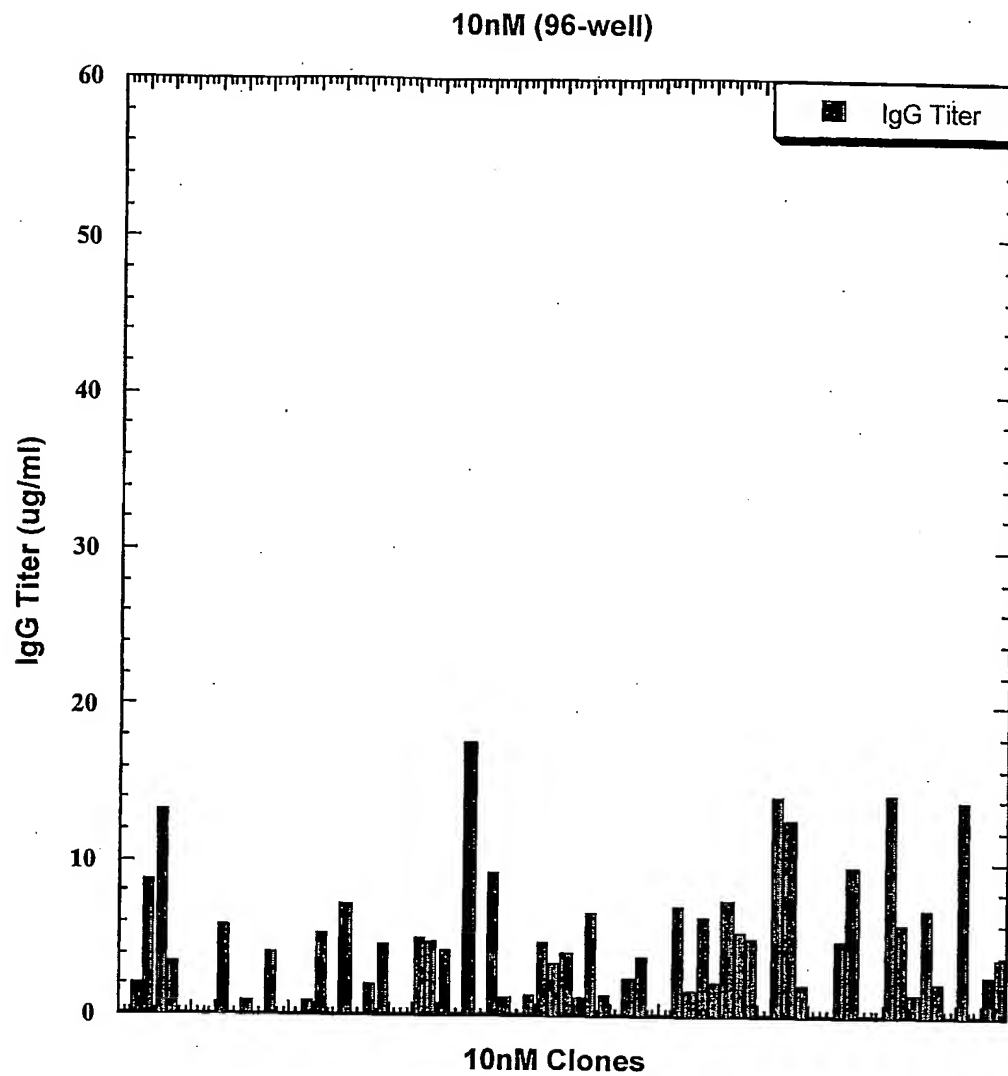
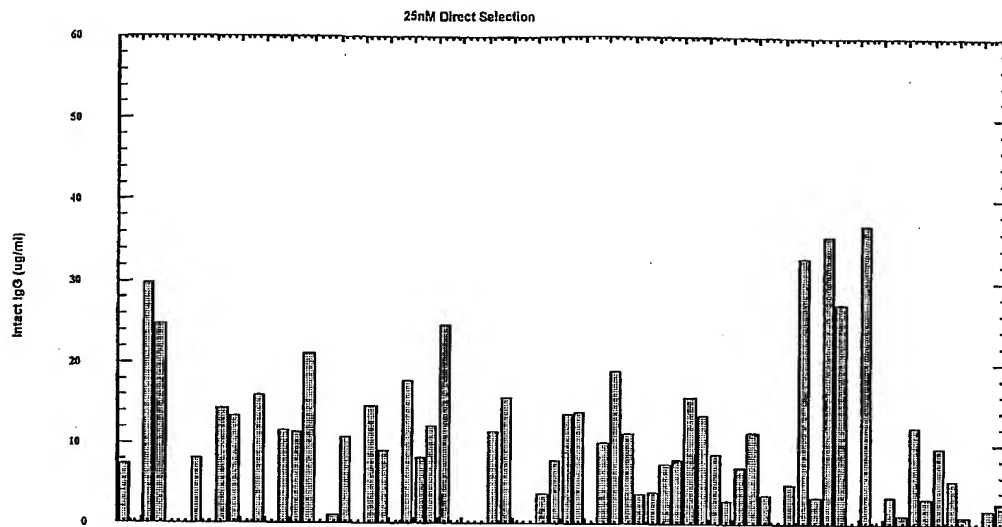
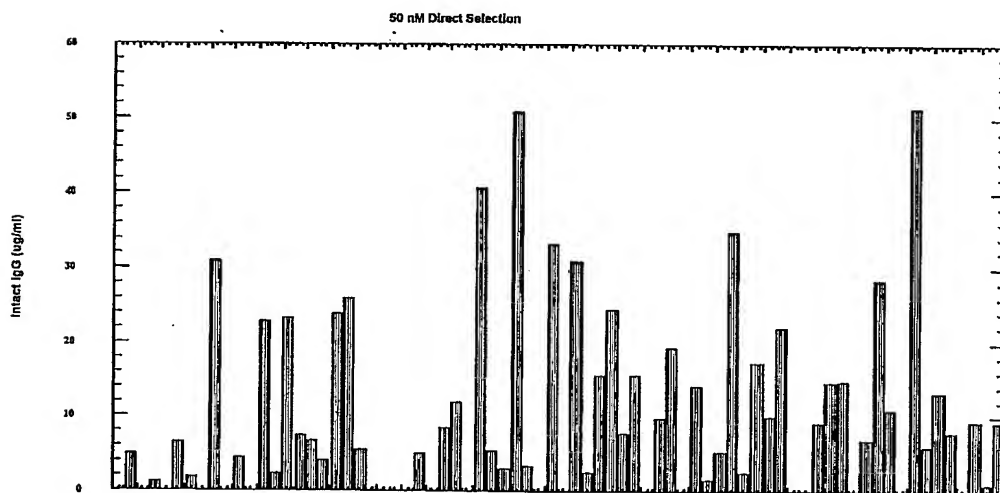


Figure 9. Expression level of clones from traditional 10 nM MTX selection.

**Figure 10-1****Figure 10-2**

Figures 10.1 and 10.2. Expression level of clones from 25 and 50 nM MTX direct selections of SV40-based constructs derived from spinner transfection, respectively.

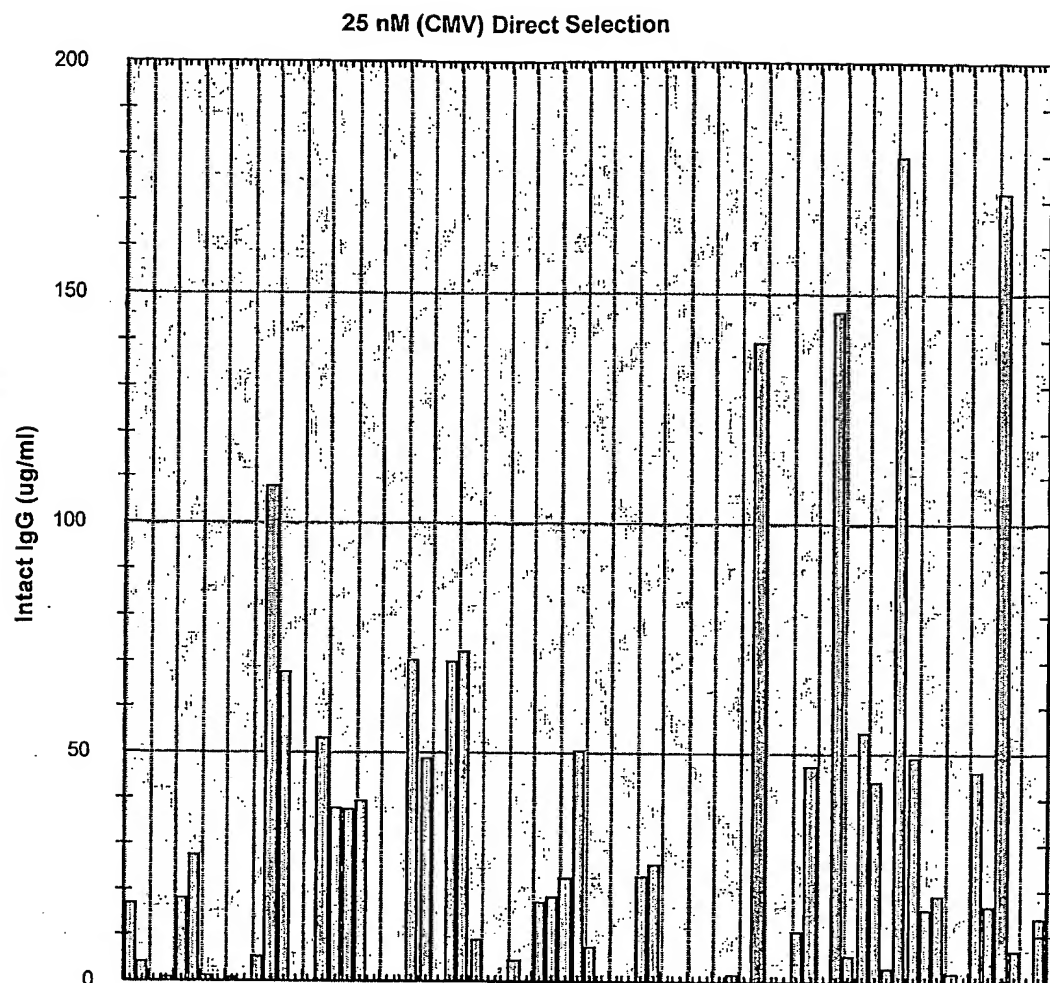


Figure 11. Expression level of clones from 25 nM MTX direct selection of CMV construct derived from spinner transfection.

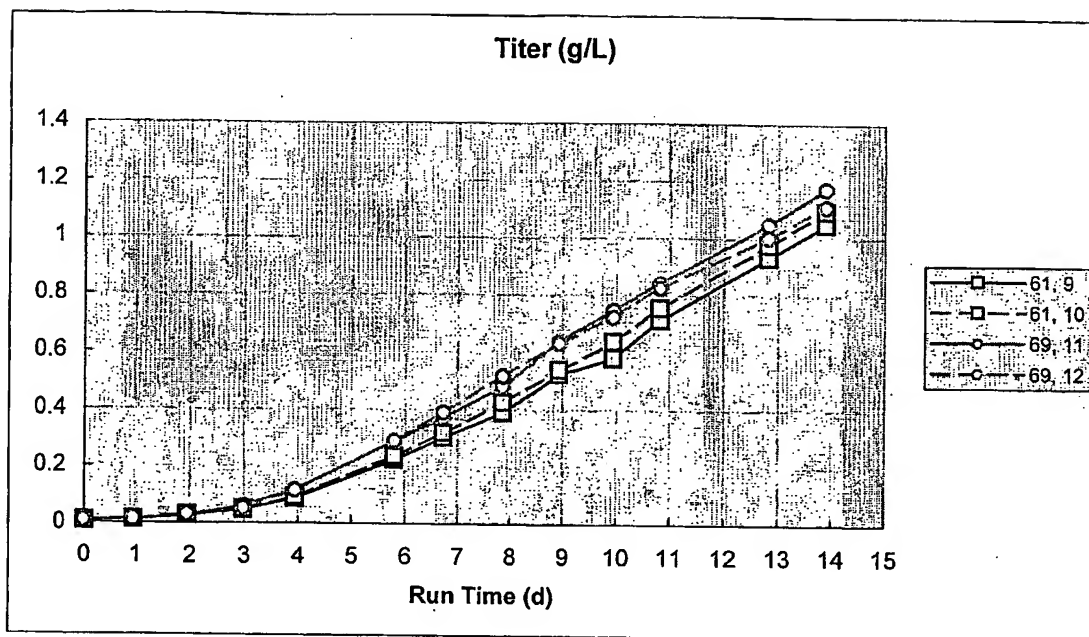


Figure 12. Titer Evaluation in Miniferm.

Figure 13. Plasmid pCMV.IPD.Heterologous Polypeptide

5 <400>
60 TTCGAGCTCG CCCGACATTG ATTATTGACT AGAGTCGATC ACCGGTAGTA ATCAATTACG
120 GGGTCATTAG TTCATAGCCC ATATATGGAG TTCGGCGTTA CATAACTTAC GGTAAATGGC
180 CCGCCTGGCT GACCGCCCAA CGACCCCCGC CCATTGACGT CAATAATGAC GTATGTTCCC
240 ATAGTAACGC CAATAGGGAC TTTCATTGA CGTCAATGGG TGGAGTATTT ACGGTAAACT
300 GCCCACTTGG CAGTACATCA AGTGTATCAT ATGCCAAGTA CGCCCCCTAT TGACGTCAAT
360 GACGGTAAAT GGCCCGCCTG GCATTATGCC CAGTACATGA CCTTATGGGA CTTTCCTACT
420 TGGCAGTACA TCTACGTATT AGTCATCGCT ATTACCATGG TGATGCGGTT TTGGCAGTAC
480 ATCAATGGGC GTGGATAGCG GTTTGACTCA CGGGGATTTC CAAGTCTCCA CCCCATTTGAC
540 GTCAATGGGA GTTTGTTTG GCACCAAAAT CAACGGGACT TTCCAAAATG TCGTAACAAC
600 TCCGCCCCAT TGACGCAAAT GGGCGGTAGG CGTGTACGGT GGGAGGTCTA TATAAGCAGA
660 GCTCGTTTAG TGAACCGTCA GATCGCCTGG AGACGCCATC CACGCTGTTT TGACCTGGGC
720 CCGGCCGAGG CCGCCTCGGC CTCTGAGCTA TTCCAGAAGT AGTGAGGAGG CTTTTTTGGA
780 GGCCTAGGCT TTGCAAAAA GCTAGCTTAT CCGGCCGGGA ACGGTGCATT GGAACGGGA
840 TTCCCCGTGC CAAGAGTGAC GTAAGTACCG CCTATAGAGC GACTAGTCCA CCATGACCGA
900 GTACAAGCCC ACGGTGCGCC TCGCCACCCG CGACGACGTC CCGCGGGCCG TACGCACCCT

Figure 13.1

960 GCGCGCGCGG TTGCGCGGACT ACCCGGCCAC GCGCCACACC GTAGACCCGG ACCGCCACAT
1020 CGAGCGGGTC ACGGAGCTGC AAGAACTCTT CCTCAGCGGC GTCGGGCTCG ACATCGGCAA
1080 GGTGTGGGTC GCGGACGACG GCGCGCGGGT GCGGTCTGG ACCACGCCGG AGAGCGTCTGA
1140 AGCGGGGGCG GTGTTGCGCG AGATCGGCCC GCGCATGGCC GAGTTGAGCG GTTCCCGGCT
1200 GCGCGCGCAG CAACAGATGG AAGGCCTCCT GCGCGCCGAC CGGCCCAAGG AGCCCGCGTG
1260 GTTCCTGGCC ACCGTGGCG TCTGCCCCGA CCACCAGGC AAGGTCTGG GCAGGCGCGT
1320 CGTGCTCCCC GGAGTGGAGG CGCGCGGCG GCGCGGGTG CCGCCTTCC TGGAGACCTC
1380 CGCGCCCCGC AACCTCCCT TCTACGAGCG GCTCGGCTTC ACCGTCACCG CCGACGTCTGA
1440 GGTGCCCCGA GGACCGCGCA CCTGGTGCAT GACCCGCAAG CCGGTGCCA ACATGGTTCC
1500 ACCATTGAAC TGCATCGTCG CCGTGTCCCA AAATATGGG ATTGGCAAGA ACGGAGACCT
1560 ACCCTGGCCT CCGCTCAGGA ACGCGTTCAA GACTTCCAA AGAATGACCA CAACCTCTTC
1620 AGTGAAGGT AAACAGAATC TGGTGATTAT GGGTAGGAAA ACCTGGTTCT CCATTCTTGA
1680 GAAGAATCGA CCTTTAAAGG ACAGAATTAA TATAGTTCTC AGTAGAGAAC TCAAAGAACC
1740 ACCACGAGGA GCTCATTTTC TTGCCAAAAG TTTGGATGAT GCCTTAAGAC TTATTGAACA
1800 ACCGGAATTG GCAAGTAAAG TAGACATGGT TTGGATAGTC GGAGGCAGTT CTGTTTACCA
1860 GGAAGCCATG AATCAACCAG GCCACCTCAG ACTCTTTGTG ACAAGGATCA TGCAGGAATT
1920 TGAAGTGAC ACGTTTTTCC CAGAAATTGA TTGGGGAAA TATAAACCTC TCCCAGAATA
1980 CCCAGGCGTC CTCTCTGAGG TCCAGGAGGA AAAAGGCATC AAGTATAAGT TTGAAGTCTA

Figure 13.2

2040 CGAGAGAGAAA GACTAACGTT AACTGCTCCC CTCTAAAGC TATGCATTTT TATAAGACCA
2100 TGAGACTTTT GCTGGCTTTA GATCCCTTG GCTTCGTTAG AACGCAGCTA CAATTAAATAC
2160 ATACCTTAT GTATCATACA CATACGATTT AGGTGACACT ATAGAATAAC ATCCACTTTG
2220 CCTTCTCTC CACAGGTGTC CACTCCAGG TCCRACTGCA CCTCGGTICT ATCGATTGAA
TTCACC --Insert Sequence of Interest--
CGA TGGCCGCCAT GGCCCAACTT GTTTATTGCA GCTTATAATG
GTTACAATA AAGCAATAGC ATCACAATTT TCACAAATAA AGCATTTTTT TCACTGCATT
CTAGTTGTGG TTGTGCCAA CTCATCAATG TATCTTATCA TGCTGGATC GGAATTAAT
TCGGCGCAGC ACCATGGCCT GAAATAACCT CTGAAAGAGG AACTTGGTTA GGTACCTATT
AATAGTAATC AATTACGGG TCATTAGTTC ATAGCCCAT TATGGAGTTC CGGTTACAT
AACTTACGGT AAATGGCCG CCTGGCTGAC CGCCCAACGA CCCCCGCCA TTGACGTCAA
TAATGACGTA TGTTCCCATA GTAAGCCAA TAGGGACTTT CCATTGACGT CAATGGGTGG
AGTATTTACG GTAAACTGCC CACTTGGCAG TACATCAAGT GTATCATATG CCAAGTACGC
CCCCATTGA CGTCAATGAC GGTAATGGC CCGCCTGGCA TTATGCCAG TACATGACCT
TATGGGACTT TCCTACTTGG CAGTACATCT ACGTATTAGT CATCGCTATT ACCATGGTGA
TGCGGTTTTG GCAGTACATC AATGGGCGTG GATAGCGGTT TGA CTCACGG GATTTCCAA
GTCTCCACCC CATTGACGTC AATGGGAGTT TGTTTTGGCA CCAAAATCAA CGGGACTTTC
CAAAATGTG TAACAACCTCC GCCCCATTGA CGCAATGGG CGGTAGGCGT GTACGGTGGG

Figure 13.3

AGTCTATAT AAGCAGAGCT CGTTTAGTGA ACCCTCAGAT CGCCTGGAGA CGCCATCCAC
GCTGTTTTGA CCTGCTAGCT TATCCGGCCG GGAACGGTGC ATTGGAACGC GGATTCCTCCG
TGCCAAGAGT CAGGTAAGTA CCGCTATAG AGTCTATAG CCCACCCCTT TGGCTTCGTT
AGAACGGCGC TACAATTAAT ACATAACCTT TTGGATCGAT CCTACTGACA CTGACATCCA
CTTTTCTTT TTCTCCACAG GTGTCCACTC CCAGGTCCAA CTGCACCTCG GTTCGGGAAG
CTCGCTTGGG CTGCATCGAT TGAATCCAC C --Insert Sequence of Interest--
CGATGG CCGCCATGGC CCAACTTGTT TATTGCAGCT TATAATGGTT
ACRAATAAAG CAATAGCATC ACAAATTCA CAAATAAAGC ATTTTTTTCA CTGCATTCTA
GTTGTGGTTT GTCCAAACTC ATCAATGTAT CTTATCATGT CTGGATCGGG AATTAAATCG
GGCAGACACC ATGGCCTGAA ATAAAGTTAA ACCCTCTGAA AGAGGAACCTT GGTAGGTAC
CGACTAGTCT TTTGCAAAAA GCTGTACCT CGAGCGGCCG CTTAATTAAG GCGCGCCATT
TAATCCTGC AGTAACAGC TTGSCACTGG CCGTCGTTTT ACAACGTCGT GACTGGGAAA
ACCCTGGCGT TACCAACTT AATCGCCTTG CAGCACATCC CCTTTCGCC AGCTGGCGTA
ATAGCGAAGA GGCCCGCACC GATCGCCCTT CCCACAGTT GCGCAGCCTG AATGGCGAAT
GGCGCCTGAT GCGGTATTTT CTCCTTACGC ATCTGTGCGG TATTTCACAC CGCATACGTC
AAAGCAACCA TAGTACGCGC CCTGTAGCGG CGCATTAAAG CCGCGGGGTG TGGTGGTTAC
GGCAGCGTG ACCGCTACAC TTGCCAGCGC CTTAGCGCCC GCTCCTTTTCG CTTTCTTCCC
TTCCTTCTC GCCACGTTTC CCGGCTTTC CCGTCAAGCT CTAATCGGG GGCTCCCTTT

Figure 13.4

AGGTTCCGA TTTAGTGCTT TACGGCACCT CGACCCCAAA AAACCTGATT TGGGTGATGG
TTCACGTAGT GGGCCATCG CCGATAGAC GGTTTTCGC CCTTGACGT TGGAGTCCAC
GTTCTTTAAT AGTGGACTCT TGTTCCAAAC TGAACAACA CTC AACCTA TCTCGGGCTA
TTCTTTTGAT TTATAAGGA TTTTGCCGAT TCGGCCCTAT TGGTTAAAA ATGAGCTGAT
TTAACAAAA TTTAACGCGA ATTTTAACA AATATTAAAG TTTACAATTT TATGGTGCAC
TCTCAGTACA ATCTGCTCTG ATGCCGCATA GTTAAGCCAG CCGGACACC GCCCGACAC
CCGCCAACAC CCGCTGACGC GCCCTGACGG GCTTGCTGTC TCCCGGCATC CGCTTACAGA
CAAGCTGTGA CCGTCTCCGG GAGCTGCATG TGTCAGAGGT TTTACCCGTC ATCACCAGAA
CGCGCGAGAG ACGAAAGGGC CTCGTGATAC GCCTATTTTT ATAGTTAAT GTCATGATAA
TAATGGTTTC TTAGACGTCA GGTGGCACTT TTCGGGGAAA TGTGCGCGGA ACCCCTATTT
GTTTATTTTT CTAATATACAT TCAAATATGT ATCCGCTCAT GAGACAATAA CCTGTATAA
TGCTTCAATA ATATTGAAAA AGGAAGAGTA TGAGTATTCA ACATTTCCGT GTCGCCCTTA
TTCCCTTTTT TCGGGCAATT TGCCTTCCTG TTTTGTCTCA CCCAGAAACG CTGGTGAAAG
TAAAGATGC TGAAGATCAG TTGGGTGCAC GAGTGGGTTA CATCGAACTG GATCTCAACA
GCGGTAGAT CCTTGAGAT TTTCCGCCCG AAGAACGTTT TCCAATGATG AGCACTTTTA
AAGTTCCTCT ATGTGGCGCG GTATTATCCC GTATTGACCG CGGGCAAGAG CAACTCGGTC
GCCGATACA CTATTCTCAG AATGACTGG TTGAGTACTC ACCAGTCACA GAAAAGCATC
TTACGGATGG CATGACAGTA AGAGAATTAT GCAGTGTCTG CATAACCATG AGTGATAACA

Figure 13.5

CTGCGGCCAA CTTACTTCTG ACAACGATCG GAGGACCGAA GGAGCTAACC GCTTTTTTGC
ACAACATGGG GGATCATGTA ACTCGCCTTG ATCGTTGGGA ACCGAGCTG AATGAAGCCA
TACCAAACGA CGAGCGTGAC ACCACGATGC CTGTAGCAAT GGCAACAACG TTGCGCAAC
TATTAACCTGG CGAACTACTT ACTCTAGCTT CCGGGCAACA ATTAATAGAC TGGATGGAGG
CGGATAAAGT TGCAGGACCA CTTCTGCGCT CGGCCCTTCC GGCTGGCTGG TTTATTGCTG
ATAAATCTGG AGCGGGTGAG CGTGGGTCTC GGGGTATCAT TGCAGCACTG GGGCCAGATG
GTAAGCCCTC CCGTATCGTA GTTATCTACA CGACGGGGAG TCAGGCAACT ATGGATGAAC
GAAATAGACA GATCGCTGAG ATAGGTGCCT CACTGATTAA GCATTGGTAA CTGTCAGACC
AAGTTTACTC ATATATACTT TAGATTGATT TAAAACTTCA TTTTAAATTT AAAAGGATCT
AGGTGAAGAT CCTTTTGGAT AATCTCATGA CCAAAATCCC TTAACGTGAG TTTTTCGTTCC
ACTGAGCGTC AGACCCCGTA GAAAAGATCA AAGGATCTTC TTGAGATCCT TTTTTCTGC
GCGTAATCTG CTGCTTGCAA ACHAAAAAAC CACCGCTACC AGCGGTGGTT TGTTTGCCGG
ATCAAGAGCT ACCAACTCTT TTTCCGAAGG TAACTGGCTT CAGCAGAGCG CAGATACCAA
ATACTGTTCT TCTAGTGTAG CCGTAGTTAG GCCACCACTT CAAGAACTCT GTAGCACCGC
CTACATACCT CGCTCTGCTA ATCCTGTTAC CAGTGGCTGC TGCCAGTGGC GATAAGTCGT
GTCTTACCGG GTTGGACTCA AGACGATAGT TACCGGATAA GGCGCAGCGG TCGGGCTGAA
CGGGGGGTTT GTGCACACAG CCCAGCTTGG AGGAAACGAC CTACACCGAA CTGAGATACC
TACAGCGTGA GCTATGAGAA AGCGCCACGC TTCCCGAAGG GAGAAAGGCG GACAGGTATC

Figure 13.6

CGGTAAGCGG CAGGGTCGGA ACAGGAGAGC GCACGAGGGA GCTTCCAGGG GGAAACGCCT
GGTATCTTTA TAGTCCTGTC GGGTTTCGCC ACCTCTGACT TGAGCGTCGA TTTTGTGAT
GCTCGTCAGG GGGGCGGAGC CTATGGAAA ACGCCAGCAA CGCGGCCTTT TTACGGTTCC
TGGCCTTTTG CTGGCCTTTT GCTCACATGT TCTTTCCTGC GTTATCCCCT GATTCTGTGG
ATAACCGTAT TACCGCCTTT GAGTGAGCTG ATACCGCTCG CCGCAGCCGA ACGACCGAGC
GCAGCGAGTC AGTGAGCGAG GAAGCGGAAG AGCGCCCAAT ACGCAAACCG CCTCTCCCG.
CGCGTTGGCC GATTCATTAA TGCAGCTGGC ACGACAGGTT TCCCGACTGG AAAGCGGGCA
GTGAGCGCAA CGCAATTAAT GTGAGTTAGC TCACCTCATTG GGCACCCAG GCTTTACACT
TTATGCTTCC GGCTCGTATG TTGTGTGGAA TTGTGAGCGG ATAACAATTT CACACAGGAA
ACAGCTATGA CATGATTACG AATTAA

Figure 13.7

Figure 14. Plasmid SV40.IPD.Heterologous Polypeptide

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6      <400>
60      TTCGAGCTCG CCCGACATTG ATTATTGACT AGAGTCGATC GACAGCTGTG GAATGTGTGT
120     CAGTTAGGGT GTGGAAAGTC CCCAGGCTCC CCAGCAGGCA GAAGTATGCA AAGCATGCAT
180     CTCAATTAGT CAGCAACCAG GTGTGGAAG TCCCAGGCT CCCCAGCAGG CAGAAGTATG
240     CAAAGCATGC ATCTCAATTA GTCAGCAACC ATAGTCCCGC CCCTAACTCC GCCCATCCCG
300     CCCCTAACTC CGCCCAGTTC CGCCCATTCT CGCCCCCATG GCTGACTAAT TTTTTTATT
360     TATGCAGAGG CCGAGGCCGC CTCGGCCTCT GAGCTATTCC AGAAGTAGTG AGGAGGCTTT
420     TTTGGAGGCC TAGGCTTTG CAAAAGCTA GCTTATCCGG CCGGGAACGG TGCATTGGAA
480     CGCGGATCC CCGTGCCAAG AGTGACGTAA GTACCGCCTA TAGAGCGACT AGTCCACCAT
540     GACCGAGTAC AAGCCACCGG TGGGCCCTCGC CACCCGCGAC GACGTCCCGC GGGCCGTACG
600     CACCCTCGCC GCCGCGTTCG CCGACTACCC CGCCACGCGC CACACCGTAG ACCCGGACCG
660     CCACATCGAG CGGGTCACCG AGCTGCAAGA ACTTCTCTC ACGCGCGTCG GGCTCGACAT
720     CGGCAAGGTG TGGGTGCGGG ACGACGGGCG CGCGTGGCG GTCTGGACCA CGCCGGAGAG
780     CGTCGAAGCG GGGCGGCTGT TCGCCGAGAT CGGCCCGCGC ATGGCCGAGT TGAGCGGTTT
840     CCGGTGGCC GCGCAGCAAC AGATGGAAGG CCTCTGGCG CCGCACCGGC CCAAGGAGCC
900     CGCGTGGTTC CTGGCCACCG TCGGCGTCTC GCCCGACCAC CAGGGCAAGG GTCTGGGCAG

```

Figure 14.1

960 CGCGCTCGTG CTCCCCGGAG TGGAGGCGGC CGAGCGCGCC GGGTGCCCCG CCTTCCTGGA
1020 GACCTCCGG CCGCGCAACC TCCCCTTCTA CGAGCGGCTC GGCTTCACCG TCACGCGCGA
1080 CGTCGAGTGC CCGAAGGACC GCGGACCTG GTGCATGACC CGCAAGCCCG GTGCCAACAT
1140 GGTTCGACCA TTGAAC TGCA TCGTCGCCGT GTCCCAAAAT ATGGGGATTG GCAAGAACGG
1200 AGACCTACCC TGCCTCCGC TCAGGAACGC GTTCAAGTAC TTCCAAAGAA TGACCACAAC
1260 CTCTTCAGTG GAAGGTAAAC AGAATCTGGT GATTATGGGT AGGAAAACCT GGTCTCTCCAT
1320 TCCTGAGAAG AATCGACCTT TAAAGGACAG AATTAATATA GTTCTCAGTA GAGAACTCAA
1380 AGAACCACCA CGAGGAGCTC ATTTCTTTCG CAAAAGTTTG GATGATGCCT TAAGACTTAT
1440 TGAACAACCG GAATTGGCAA GTAAAGTAGA CATGGTTTG ATAGTCGGAG GCAGTTCTGT
1500 TTACCAGGAA GCCATGAATC AACCAGGCCA CCTTAGACTC TTTGTGACAA GGATCATGCA
1560 GGAATTGAA AGTGACACGT TTTTCCCAGA AATTGATTG GGGAAATATA AACCTCTCCC
1620 AGAATACCCA GCGTCTCTCT CTGAGGTCCA GGAGGAAAAA GGCATCAAGT ATAAGTTGA
1680 AGTCTACGAG AAGAAAGACT AACGTTAACT GTCCTCCCTCC TAAAGCTATG CATTTTATA
1740 AGACCATGGG ACTTTTGCTG GCATTAGATC CCCTTGGCTT CGTTAGAACG CAGCTACAAT
1800 TAATACATAA CCTTATGTAT CATACACATA CGATTAGGT GACACTATAG ATAACATCCA
1860 CTTTGCCTTT CTCCTCACAG GTGTCACACT CCAGTCCAA CTGCACCTCG GTTCTATCGA
1920 TTGAATTCCA CC -Insert Sequence of Interest-
CGATGGCC GCCATGGCCC AACTTGTGTTA TTGCAGCTTA

Figure 14.2

TAATGGTTAC AAATAAAGCA ATAGCATCAC AAATTTTACA AATAAAGCAT TTTTTCAC
 GCATTCTAGT TGTGGTTTGT CCAAACTCAT CAATGTATCT TATCATGTCT GCATCGGGAA
 TTAATTCGGC GCAGCACCAT GGCCTGAAAT AACCTCTGAA AGAGGAACTT GGTAGGTAC
 CTTCTGAGC GGAAGAACC AGCTGTGGAA TGTGTGTCAG TTAGGGTGTG GAAAGTCCCC
 AGGCTCCCCA GCAGGCAGAA GTATGCAAAG CATGCATCTC AATTAGTCAG CAACCAGGTG
 TGGAAAGTCC CCAGGCTCCC CAGCAGGCAG AAGTATGCAA AGCATGCATC TCAATTAGTC
 AGCAACCATA GTCCCGCCCC TAACTCCGCC CATCCCGCCC CTAACCTCCG CCAGTTCCGC
 CCATTCTCG CCCCATGGCT GACTAATTTT TTTTATTTAT GCAGAGGCCG AGGCCGCCCTC
 GGCCTCTGAG CTATTCCAGA AGTAGTGAGG AGGCTTTTTT GGAGGAGCTT TTGCAAAAAG
 CTAGCTTATC CGGCCGGGAA CGGTGCATTG GAACGCGGAT TCCCGGTGCC AAGAGTCAGG
 TAAGTACCGC CTATAGAGTC TATAGGCCCA CCCCCTTGGC TTCGTTAGAA CGCGGCTACA
 ATTAATACAT AACCTTTTGG ATCGATCCTA CTGACACTGA CATCCACITT TTCTTTTCT
 CCACAGGTGT CCACTCCCAG GTCCAACTGC ACCTCGGTTT CCGAAGCTAG CTGGGGCTGC
 ATCGATTGAA TTCCACC -Insert Sequence of Interest-
 CGATGGCCGC CATGGCCCAA CTGTGTTTAT GCAGCTTATA ATGGTTACAA ATAAAGCAAT
 AGCATCACAA ATTCACAAA TAAAGCAATT TTTTCACTGC ATTCTAGTTG TGGTTTGTCC
 AAACATCAAT ATGTATCTTA TCATGTCTGG ATCGGGAATT AATTGGGCGC AGCACCATGG
 CCTGAATATA GTTTAAACCC TCTGAAGAG GAACTTGTTT AGGTACCGAC TAGTCTTTTG

Figure 14.3

CAAAAAGCTG TTACCTCGAG CGGCCGCTTA ATTAAGGCG GCCATTAAA TCCTGCAGGT
AACAGCTTGG CACTGGCCGT CGTTTTACAA CGTCGTGACT GGGAAAACCC TGGCGTTACC
CAACTTAATC GCCTTGCAGC ACATCCCCCT TTCGCCAGCT GCGTAATAG CGAAGAGGCC
CGCACCGATC GCCCTTCCCA ACAGTTGCGC AGCCTGAATG GCGAATGGCG CCTGATGCGG
TATTTTCTCC TTACGCACT GTGCGGTATT TCACACCGCA TACGTCAAAG CAACCATAGT
ACGCGCCCTG TAGCGGCGCA TTAAGCGCG GGGGTGTGGT GGTACGCGC AGCGTGACCG
CTACACTTGC CAGCGCCCTA GCGCCGCTC CTTTCGCTT CTTCCTTCC TTTCTCGCCA
CGTTCGCCG CTTTCCCCGT CAAGCTCTAA ATCGGGGGCT CCCTTTAGGG TTCCGATTTA
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Figure 14.4

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Figure 14.5

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Figure 14.6

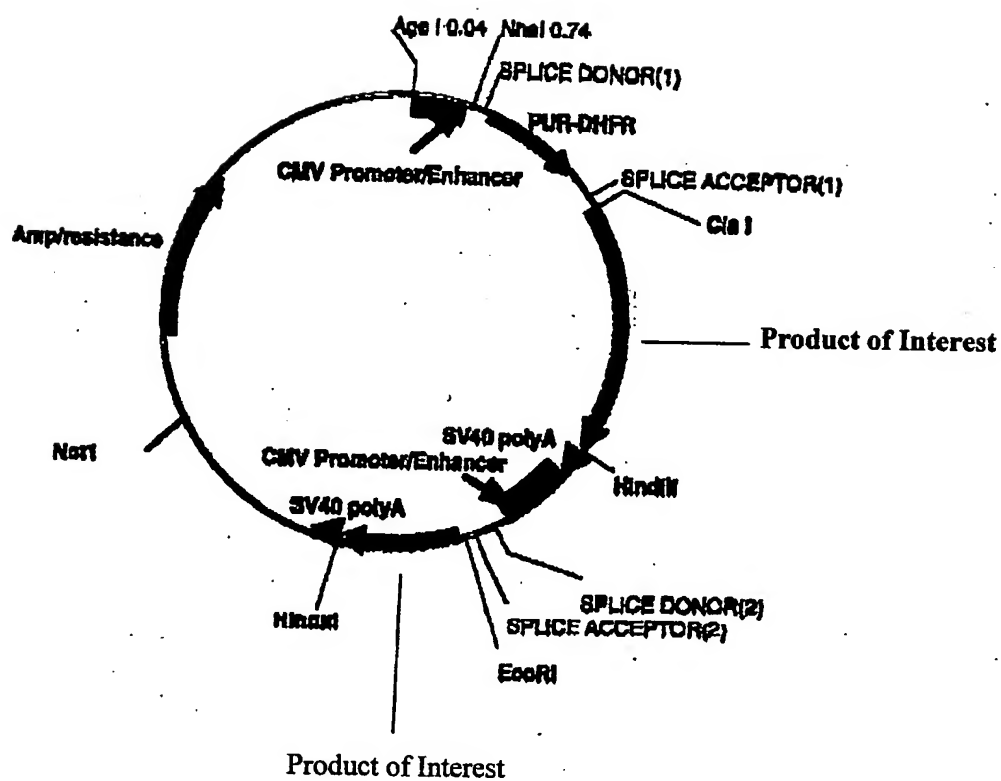


Figure 15. pCMV.IPD.HP

Timeline and Titer Comparison

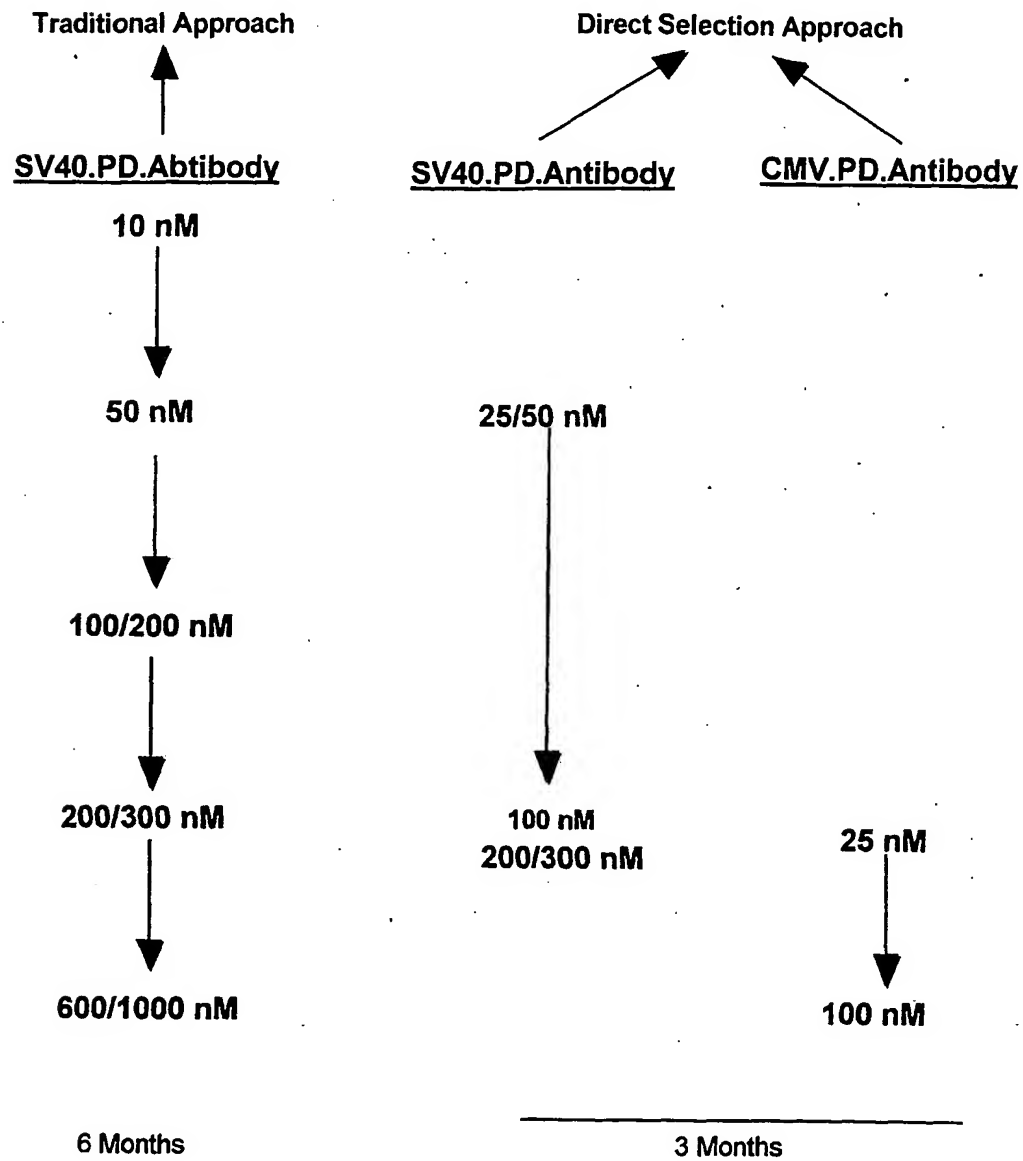


Figure 16. Timeline and Titer Comparison.

SEQUENCE LISTING

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 Chisum, Venessa

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<212> DNA
<213> Artificial

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<220>
<223> plasmid pSV.IPD circular ds-DNA

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<220>
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<222> (444)..(444)
<223> splice donor

```

```

<220>
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<222> (479)..(479)
<223> start PUR coding

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```

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